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Forty-three blind subjects, aged 17 to 45, were tested for perceptual thresholds of locomotion and received brief mobility training. Psychometric and psychological data obtained indicated that the subjects were above average in IQ (mean 115), emotionally stable, and relatively free from anxiety. Data on locomotion revealed the following: 91% of the subjects veered consistently in the same direction when asked to walk a straight line; and the subjects who walked faster tended to veer less and those who were more accurate in walking in a straight line and in performing 90 degree facing movements were better at position relocation in a field. The threshold to the perception of left-right tilt in pathways walked was slightly under 2 degrees; subjects were more sensitive to walking a downhill gradient than an uphill gradient. On facing movements, the blind and the blind-folded sighted overturned 90 degree turns and underturned 180 and 360 degree turns. Practice modified the veering tendency significantly after 200 feet; the directions a subject habitually veered trying to draw a straight line and to walk a straight line on a field were related ($p=.10$). Results not reaching statistical significance are also reported. (Author/JD)

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PERCEPTUAL THRESHOLDS OF NON-VISUAL LOCOMOTION

Part II

The effects of brief practice upon veer, upon accuracy of facing movements and upon position re-location. The perception of lateral tilt in pathways walked and of curvature of curbs. The relationship of accuracy of performance in selected table-top drawing tasks to the veering tendency and to position re-location.

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Carried out under the sponsorship of the Department of Health, Education and Welfare, Public Health Services, the National Institute of Neurological Diseases and Blindness (NB 05577-0251).

Department of Physical Education, University of California
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Special thanks are also due to the subjects. Not only did they willingly spend their time and energies patiently being tested in a wide variety of tasks, but also frequently offered valuable suggestions which it is believed contributed in a positive way to the practicality of the results.

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CHAPTER I

INTRODUCTION

This investigation represents, in part, an extension of studies carried out during the initial year of this project. Several new problems explored this year were suggested by mobility trainers who inspected the first year's findings. Other components of the study suggested themselves as a result of careful study of the findings of last year's investigation.

Following the collection of normative data during the past year, it was decided that during the second year it would be profitable to utilize fewer subjects and to study their perceptual-motor abilities in more detail by testing each of them for a longer period of time. Thus the data presented here represent scores collected from almost fifty subjects each of whom spent two days at the University, the initial testing period was during the weekend of February 5th and 6th, 1966; the second day between the 5th and 9th of April. The subjects were thus subjected to two days of testing approximately two months apart.

Prior to testing the blind subjects, several pilot investigations were carried out using available blindfolded collegians. These pilot studies were conducted in order to survey problems related to test administration as well as to determine the reliability of some of the measures to be used. These studies, it is believed, contributed materially to the quality of the final investigation. Approximately 150 sighted subjects volunteered as participants in these initial investigations which were carried out during the Fall of 1965.

While the primary focus of the initial year's efforts was directed toward the collection of normative data, the focus during this second year was upon exploring the influence of brief practice upon some of the perceptual-motor attributes studied initially. In addition, it was decided to explore some other variables which might relate to the ability to make the gross perceptual judgments investigated. Thus three tests were administered which purport to measure emotional and intellectual characteristics of the blind. These included Bauman's Emotional Factors Inventory, Taylor's Test of Manifest Anxiety, and the verbal part of the Wechsler Adult Intelligence Scale.

Auxiliary investigations during this second year included exploring (1) the relationship between performances in which blind subjects were asked to draw a straight line directly away from their bodies and the tendency of the total body to veer when walking without vision; (2) the ability to detect the curvature of curbs of various radii with a cane and (3) the ability to re-locate the initial starting position of the body on a field after being guided away from this point along an 'L' shaped pathway.

The details of the methodology involved in exploring these sub-problems are presented in Chapter III. The remainder of the monograph is organized as follows: Chapter II reviews the pilot studies carried out and the relevance of these findings to the primary investigation; Chapter III presents a description of the methods and procedures utilized; Chapter IV presents the data analysis and findings; Chapter V contains a discussion of the findings. Here both theoretical and practical implications are dealt with. A detailed review of the literature has not been accorded a separate section in this monograph. For this kind of summary, the reader is referred to Chapter II in the initial monograph of this series. (5) Pertinent literature is cited where it is appropriate, and references to related studies are integrated into the body of the text.

CHAPTER II

PILOT INVESTIGATIONS

Initially, several pilot studies were conducted in order to: (a) study testing procedures intended for final investigations with the blind and (b) assess the reliability and/or to improve conditions contributing to the reliability of the measuring instruments. These pilot studies were of two kinds: (a) "informal" surveys of only a few subjects without detailed statistical treatment of the data and (b) studies of a more systematic nature involving 50 to 60 subjects, the data from which were subjected to detailed statistical analysis. The pilot studies were carried out with the intent of observing subject behaviors and collecting subjective comments from the subjects. Subjects involved in these pilot investigations were blindfolded male and female university students.

PILOT STUDY I

THE ACCURACY OF FACING MOVEMENTS, EXECUTED WITHOUT VISION

It had been observed by the primary investigator that one of the important attributes necessary in the mobility of the blind was the ability to execute facing movements accurately. These facing movements are defined as one-quarter, one-half, and full turns. A pilot study was thus initiated to explore the measurement problems inherent in the evaluation of this behavior and to collect basic data relative to the accuracy of this ability in the blindfolded-sighted individual. These data will later be compared to similar data collected from the blind (Chapter V).

A large protractor (4' x 4') was marked off in 360 degrees and placed on the floor. In the center of this apparatus was a circle 16" in diameter surrounded by a raised edge 4" high. The subjects were blindfolded and hooded, and their ears plugged with rubber earplugs under cotton. After inserting the ear plugs the subjects reported that they were unable to hear any noises other than the directions given to them by the experimenter. A belt was fastened around the waist of the subject. This belt supported a 3" long pole which projected outward from the center of the subject's body and was parallel to the ground. From the distal end of this pole a string with a plumb-bob was suspended so that as the subject turned, it was possible to determine the number of angular degrees he moved in a horizontal plane by comparing the positions of the plumb-bob in relation to the protractor before and after the turn was executed.

Twelve facing movements were requested in a random order. These included 90°, 180°, and 360° turns in both right and left directions. The findings indicated that while turns of 90 and 180 degrees were, on the average, estimated within seven degrees of the requested angle (90° turns were underturned by 7 degrees; 180° turns were overturned by about the same amount), full turns were underestimated, on the average, by 38 degrees. The direction of the turn requested did not influence accuracy. That is, the subjects as a whole were not more accurate when moving to the right than to the left. The findings did reveal, however, that individual subjects tended to turn more accurately in one direction than in another.

These findings agree only in part with the data collected by Hunter who found that congenitally blind subjects characteristically underestimated both large and small spatial dimensions. (11) Banerjee (1), on the other hand, found that blind children tended to habitually overestimate the extent of distance walked in a re-positioning task. Bartley (2) suggests that individuals may have a preferred extent of movement as it has been found that people tend to draw 4" lines longer than requested, while drawing 15" line shorter than requested.

The findings of this pilot investigation also revealed that the blindfolded collegians seemed to have a preference in the extent of angular movement executed in this type of task. A comparison of these findings with those from the blind is reported in Chapters IV and V.

The reliability of the task described varied with the kind of turn requested. Reliability coefficients were: 90° turn+.75; 180° turn+.69; 360° turn+.54. To increase the reliability of the task when administering it to the blind , it was decided to carefully monitor the rate at which the movements were requested and to make certain that the subjects kept both the heels and balls of their feet in contact with the center area when executing the turns (that is, that they performed a "shuffle" turn rather than a military facing movement). For a more detailed discussion of this pilot study, the reader is referred to Cratty and Williams (8). Figure 1 graphically summarizes most of these findings.

PILOT STUDY II

THE VEERING TENDENCY OF THE ARM, WHEN DRAWING A STRAIGHT LINE WITHOUT VISION

This second pilot study was prompted by two kinds of information. First, the initial monograph in this series presents data which suggest that the veering tendency of the total body is more influenced by some kind of perceptual distortion than by structural qualities, and secondly, Father Carrol in his text, *Blindness* (4), suggests that distortions evidenced in drawing tasks might relate to the direction in which an individual habitually veers his total body when walking without vision. Thus it was speculated that relating these two types of performances might prove interesting. For example, if the two behaviors

FIGURE 1

AVERAGE DEGREES TURNED ON THE VARIOUS TURNS BY BLINDFOLDED-SIGHTED COLLEGIANS.

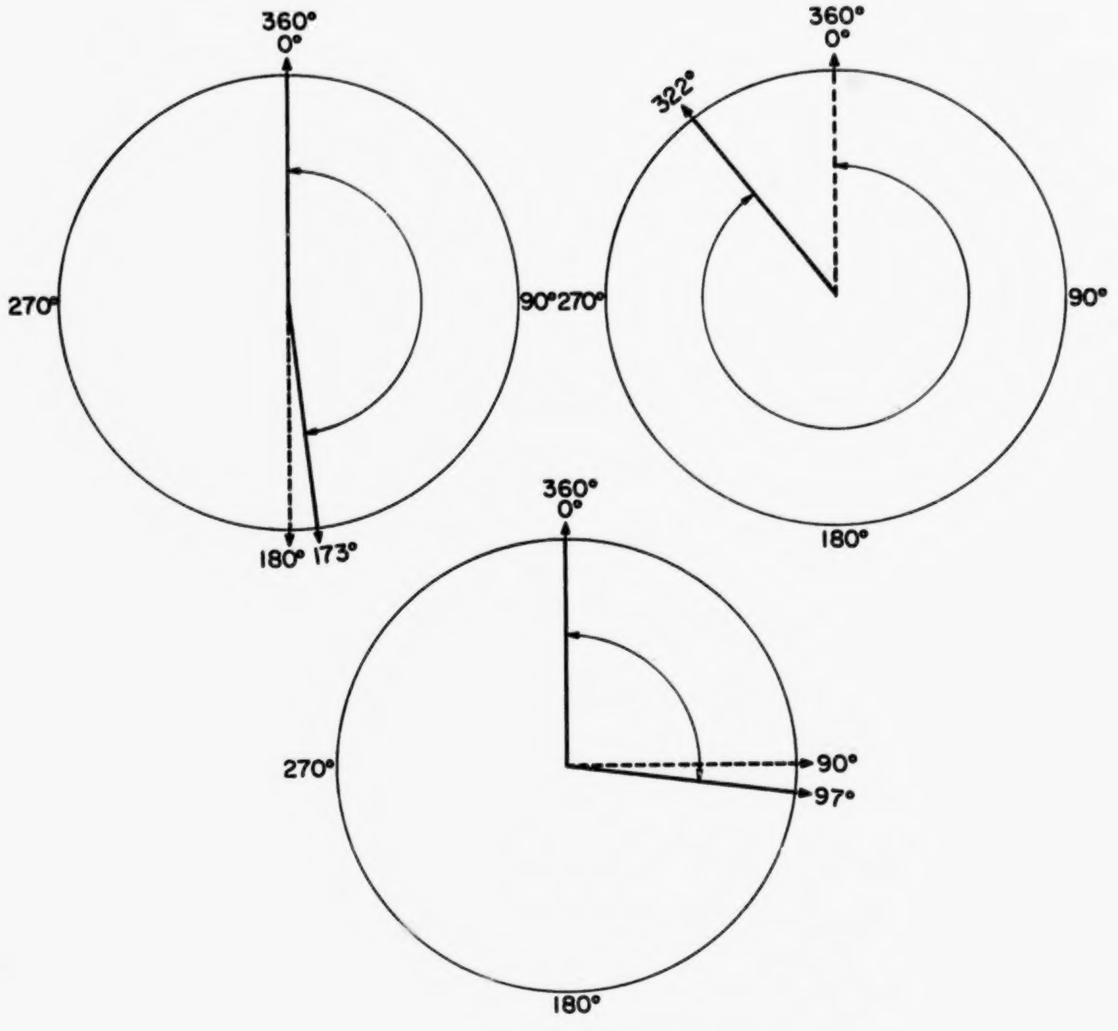
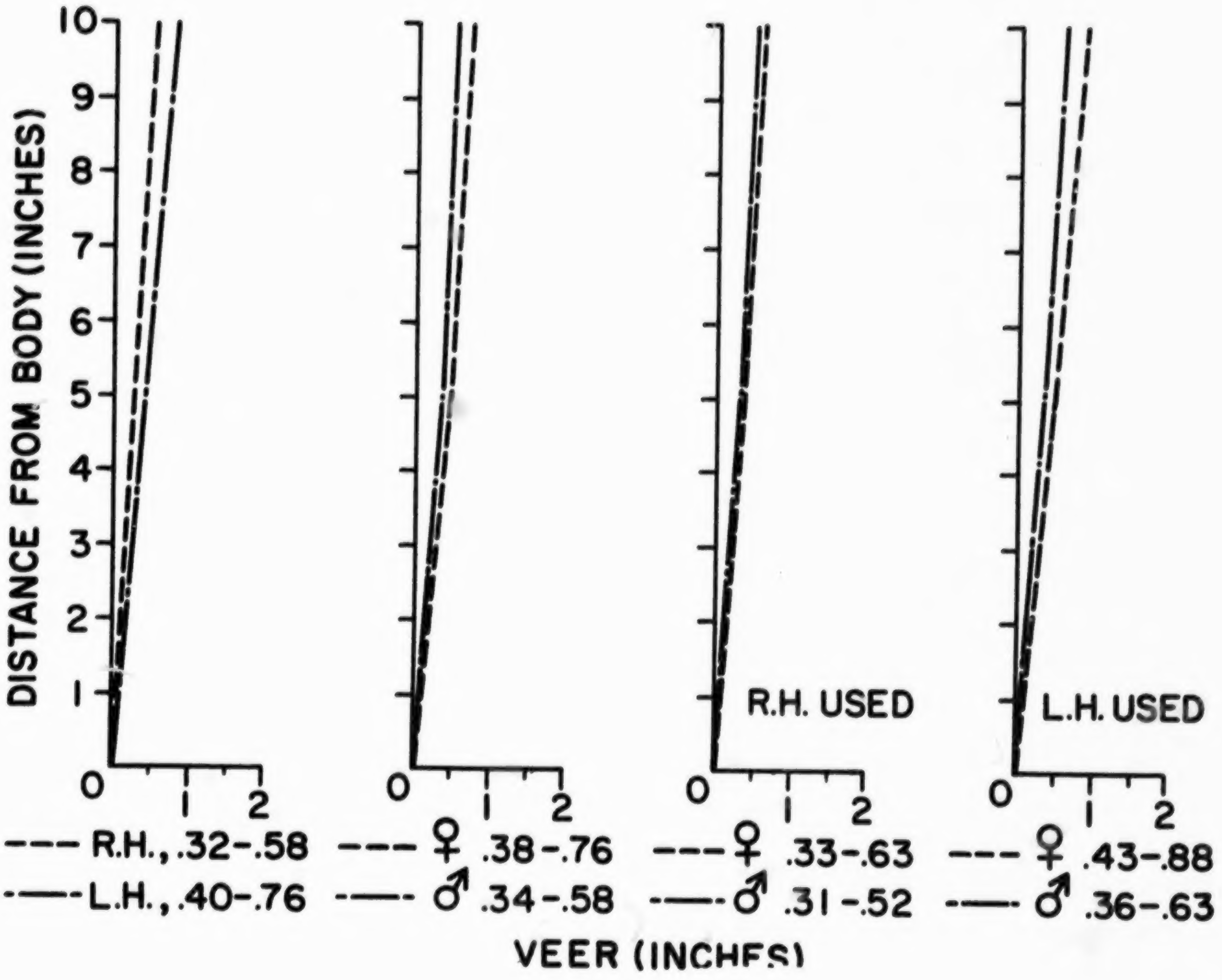

360°
0°
270°
90°
180°
173°
360°
0°
322°
270°
90°
180°
360°
0°
270°
90°
97°
180°

FIGURE 2

AMOUNT OF VEER EVIDENCED WHEN DRAWING
A "STRAIGHT" LINE WITHOUT VISION BY
BLINDFOLDED COLLEGIANS.



were related (that is, if distortion in the perception of "straightness" were general to both arm and total body movements), a table-top drawing task might be used as a helpful diagnostic and training tool with the resultant saving of time, space and physical effort. If no relationship were found, mobility trainers might confine their efforts only to gross locomotor activity when attempting to deal with veering problems.

The primary purposes of this second pilot study were to survey the accuracy with which individuals can draw a line without vision, directly away from the center of the body; to ascertain the influence of sex, hand dominance and hand used upon the execution of this task; and to determine the reliability.

Fifty-eight (58) subjects were blindfolded, hooded and seated in front of a table so that their sternums were approximately six inches from a 'starting' groove, 1 1/2 inches long at the edge of the table nearest the subject. The groove overlapped the center of a 17 x 23 inch piece of graph paper gridded with five sqaures to the inch. Using both hands twice in random order, the subjects were requested to draw a straight line with a colored pencil directly away from the edge of the table, utilizing the 'straight starting groove' for an initial orientation.

The findings suggested that, similar to movements of blind subjects on the field, a "veering tendency" was present in the performance of this task. The subjects started on an initial course and then continued on it, rather than zig-zagging back and forth.[1] They thus tended to become less accurate as they progressed from five inches to ten inches from the starting point. In general, men were more accurate than the women and seemed to be especially so when using the left hand to perform the task. A graphic representation of these findings is found in Figure 2. The direction of the line of veer was not related to the reported hand dominance of the subject. Subjects tended to veer to the left when using the right hand and to veer to the right when using the left hand. Detailed statistical analysis revealed, however, that the variables of hand and sex accounted for only a small part of the variance present in the performance thus leaving the greatest percentage of performance variance still unaccounted for.

The Analysis of Variance Model was used to estimate reliability. Coefficients were: Left Hand-.69; Right Hand-.71. (Although these same subjects were not inspected on a field attempting to walk a straight line, a comparison of this nature was carried out with the blind subjects. A discussion of these findings is found in Chapter IV, page .)

As a result of this pilot study, it was decided to incorporate such a task into the primary investigation. In addition to correcting other problems of administration, care was taken to control the manner in which the subjects held the arms and hands when attempting to draw the straight line as these were viewed as possible confounding variables.

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[1] Correlation between deviation at 5" and 10" was .89.

OTHER PILOT STUDIES

Perception of the Curvature of Curbs. Upon observing mobility training programs, the investigators noted that many of the trainees had difficulty "brailling" the curvature of curbs at corners. That is, they were unable to distinguish accurately a straight surface from a curved one using their canes. Likewise, the mobility trainers observed seemed to have little knowledge of how curved a curb should be before their blind trainee might be expected to be able to detect its configuration through the use of a cane.

With this in mind, eight wooden curbs were constructed. These had radii of 10', 15', 29', 25', 30', 35', and 40'. A straight curb was also built. Each curb was ten inches in height and was curved along a six foot arc of a circle so that they could be individually 'plugged' into a platform 4' x 4' and 10 inches high upon which the subject stood. The curbs thus projected one foot on either side of the platform.

Determining the 'correct' cane technique became a problem as verbal descriptions obtained from mobility trainers tended to differ considerably. Finally it was decided to permit the subject two methods: (a) one in which they faced the curb and used both hands alternately and (b) a second one in which they placed the side of the body toward the 'curbs' and moved their canes along its edge with one hand.

Canes of varying heights were borrowed for use in the investigation. The subjects after being blindfolded out of sight of the apparatus were instructed in both methods of detecting curvature. Prior to being blindfolded, they were also asked to 'take their time' when making the judgment.

After testing approximately 20 subjects, it became apparent that responses were being made in a random, unpredictable fashion, unrelated to the curvature of the curbs. In short, the subjects appeared to be completely unable to detect the curvature of any of the curbs presented to them using canes in the manners prescribed.

The method in which the subject faced the curbs seemed particularly ineffective. This finding was not too surprising since it is well known by reference to the human factors literature (10) that localization using kinesthetic feedback is less accurate to the sides than to the front of the body, and the most marked differences in the curvature of a curb (when facing the curb and moving the cane from hand to hand in a vertical position perpendicular to the ground) are more apparent to the sides of the body. The other method (subject's side toward the curb) seemed equally ineffective, however. Further consultation with mobility trainers suggested that the blind person primarily utilizes a sense of direction obtained from the previous 'straight' pathway taken down the sidewalk as a reference from which to judge the curvature of curbs. It is apparent, however, that the blind trainee may not be actually walking straight (5, 14) and his perceptions of this 'straightness' may become obliterated after he has stopped at the curb for a period of time.

In any case the results of this pilot study prompted the experimenters to eliminate some of the curbs from the final investigation, to include a curb with a radius of 5 feet, and to permit the blind subjects any method they chose with regard to the use of the cane.

Position Re-Location. A brief pilot study was conducted to evaluate problems relative to the ability of the blind to re-locate a given starting position after being moved away from it. A study by Worchel (19) provided a reliable measure of this ability when moving the total body via walking. A sub-problem of this investigation was to ascertain whether this ability could also be detected on a table-top task resembling that suggested by Worchel (19) and to determine the trainability of position re-location, using a right-angle triangle pattern, by first practicing on a desk and then immediately going to the field to perform the same task in a larger amount of space.

A brief pilot study was carried out with nine subjects. They were seated before a table, blindfolded, and asked to grasp a pencil with the hands overlapping. After being guided along the two adjacent sides of a right triangle, they attempted to return viá the hypotenuse to the original starting position. Four trials were given each subject first moving in a triangle to the left for two trials and then moving twice to the right. Correlation based on a test re-test was .72 for the right return and .83 for the left return.

SUMMARY

Pilot studies employing fifty-eight subjects were carried out to determine the reliability of the facing movements and line-drawing tasks. Other pilot studies were carried out to evaluate problems involved in assessing the ability of sightless subjects to detect curvature in curbs with canes and to re-locate a position in a desk-top task. Findings from these pilot studies contributed to the establishment of better administrative procedures for the primary investigation.

CHAPTER III

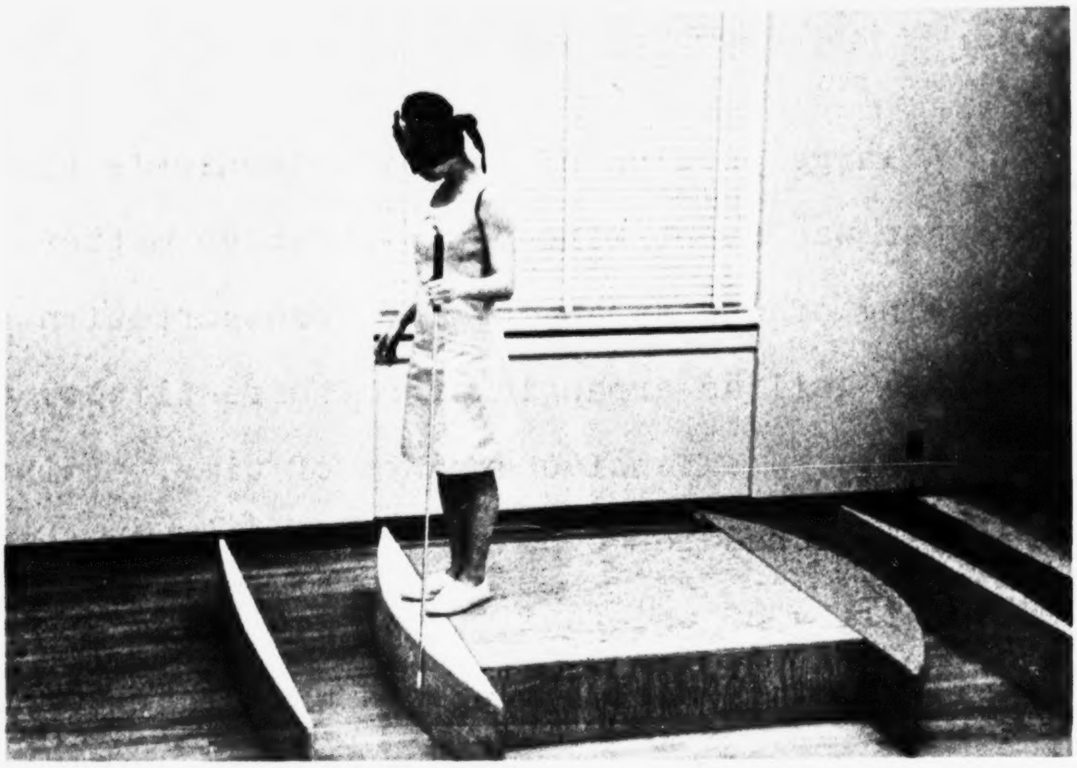
METHODS AND PROCEDURES

A large portion of the experimenter's time during the year was spent with administrative matters. The procuring of and arranging for transportation of subjects as well as arranging for the facilities to be used consumed extensive amounts of time. Initially the project had to be planned in relationship to the availability of the facilities needed for its execution. Simultaneously, subjects were located and polled concerning their availability for the project. During the fall semester equipment was designed and built, and pilot studies were conducted (Chapter II). The first data collection session was conducted, during the weekend of February 5th and 6th. The subjects visited the campus the second time during the week of April 5-9th. The majority of the testors involved had had experience working on the project during the previous year.

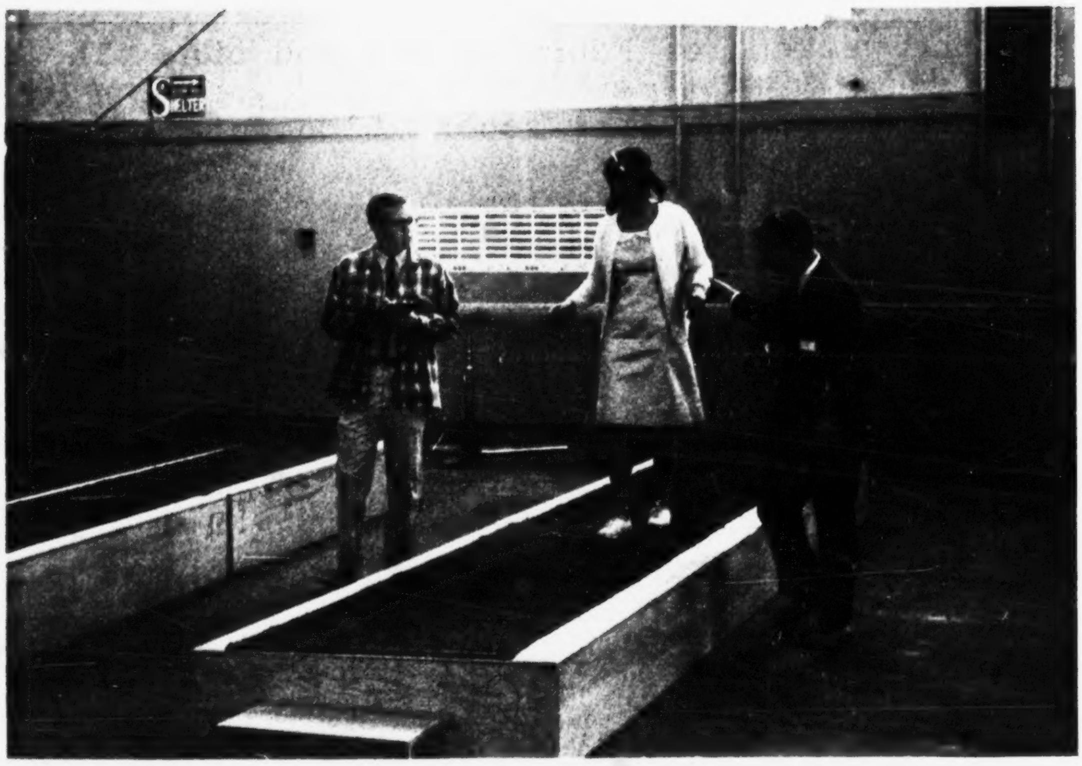
The material which follows is organized into three sections: (1) general administrative procedures; (2) data collection procedures and (3) data analysis.

Plate I

APPARATUS FOR ASSESSING THE PERCEPTION OF CURVATURE OF CURBS



RISERS USED TO ASSESS SENSITIVITY TO LATERAL TILT



ADMINISTRATIVE PROCEDURES

Facilities. Arrangements were made in September, 1965 to obtain the use of a large gymnasium (150' by 100'), and an athletic field 100 yards by 120 yards for data collection purposes. In addition four classrooms and the Perceptual-Motor Learning Laboratory were scheduled for use in the testing and orientation of subjects.

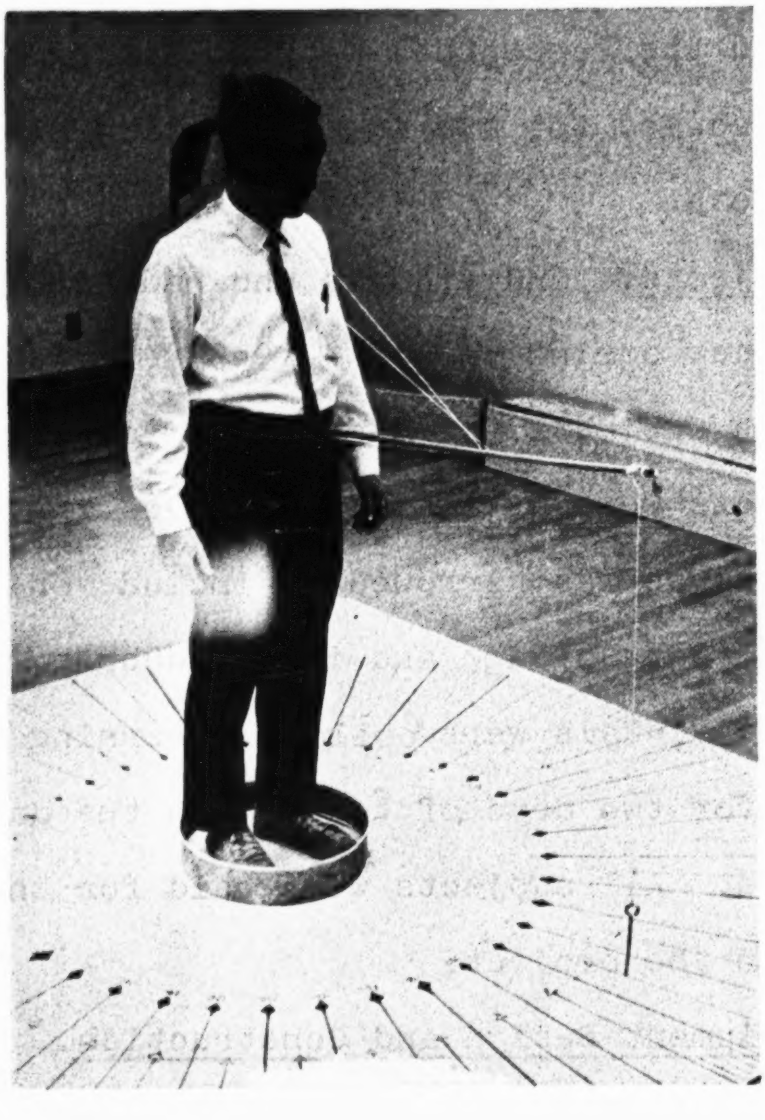
Subjects. Individuals who had participated in the project during the 1964-1965 year were contacted to act as subjects for the second year. A total of 43 subjects were ultimately involved in the project. The age range was narrowed to include only those from 17 to 55 years of age and included both men and women. These individuals were polled concerning their availability for two days of testing on the dates previously indicated. All subjects were paid for their participation in the project.

Equipment Design and Construction. Mock wooden curbs with radii of 10, 15, 20, 25, 30, 35, 40 feet were constructed. A "straight" curb was also made as well as a platform in which to insert the various curbs (Plate I).

Platforms with angular tilts of 1, 2, and 4 degrees were constructed. These displacements it was felt would be sufficient to establish rough threshold measures,

Plate 2

FACING-MOVEMENT APPARATUS



as indicated by last year's project (5). These risers were approximately 18" high, 4' wide and 8' long (Plate I).

Aluminum tubes and supports were purchased in order to provide additional starting pathways for the evaluation of the veering tendency. Suggestions by John Dupress (9), relative to the advisability of starting a subject on a veering problem by using straight guide rails rather than manually guiding them, prompted the construction of this additional equipment.

A protractor 4 x 4' that had been utilized in previous studies was renovated for use in the Facing Movement task. Two belts were also constructed.

Miscellaneous equipment and supplies were collected. These included graph paper on which to evaluate hand-veer; The Verbal portion of the Wechsler Adult Intelligence Scale; Taylor's Test of Manifest Anxiety and Mary K. Bauman's Emotional Factor Inventory. For the latter two tests, boxes with appropriately numbered cards were made so that the testee could answer a numbered question which he heard via tape by dropping a card with the corresponding number, into a "yes" or "no" box.

Testors. All tests were administered by graduate students in Psychology, special education, educational psychology, and physical education. The

Wechsler Adult Intelligence Scale was administered by five individuals, each having a Master's degee in psychology or educational psychology. Following their initial recruitment, (about 40 participated as testors, guides, and drivers) testors participated in a two hour meeting during which a film of the previous years' investigation was shown. The meeting concluded with the testors and guides forming smaller groups in which they could practice their specific functions. The guides, for example, practiced guiding each other through the facilities while blindfolded. Each testor was given a one hour orientation to the administration of their tasks and, in addition, attended two other two hour sessions during thich they were trained in the specifics of the administration of their tasks. Pilot studies related to the final test in which the testor would participate were, when possible, conducted with the help of the testors involved. Each testor received a Testor's Handbook in which pertinent information was contained. This twenty-five page handbook contained information relative to the location of testing sites, general information about the blind, and specific information about the nature of the project. Specific testing protocols were also outlined in detail in this handbook. Subsequently testors were examined on their knowledge of their specific jobs.

Data Collection Procedures. Thr first testing session involved (an evaluation of the veering tendency with and without feedback between trials (control versus experimental subjects); (b) evaluation of the accuracy with which the subject would make facing movements; (c) the perception of tilt in pathways walked; (d) the veering tendency of the arm; and (e) administration of Bauman's Emotional Factors Inventory and Taylor's Manifest Anxiety Test.

The subjects were transported to the facilities on either Saturday or Sunday. There were four to five subjects per car, and each subject spent from 4 to 5 hours in the testing situation. Lunch was provided, and they were returned to their homes by 5 P.M. The order of the tasks was arranged so that physically strenuous tasks were alternated with less demanding ones. Approximately one-half the subjects were tested on Saturday and the other half on Sunday. Inclimate weather on Sunday required the experimenters to evaluate the veering tendency in the gymnasium rather than on the field. The subjects who arrived on Sunday, and thus were tested in the gymnasium, were evaluated on the field during their second testing session in April. Conversely, those subjects initially tested on the field were tested in the gymnasium during their second visit.

During the testing session in April, the following changes were made: (a) evaluation of perception of lateral tilt, the Emotional Factors Inventory and Test of Manifest Anxiety were eliminated as the first testing supplied the needed data; (b) the table-top veer task was eliminated after the first testing as the data obtained had been satisfactory; (c) one-half of the subjects during the second testing session received a brief training program designed to improve their ability to make facing movements (d) a position re-location task was added to the field, and tables were set up adjacent to this testing area in order to evaluate the relationship of re-location ability on the table to re-location ability on the field and to determine the influence of brief table re-location training upon field re-location; (e) the Verbal portion of the Wechsler Adult Intelligence Scale was administered during this second testing session.

Overall the following ten tasks were administered:

1. Veering tendency on the field.
2. Veering tendency in the gymnasium.
3. Detection of the lateral tilt of pathways walked.
4. The accuracy of Facing Movements.
5. The veering tendency of the arm.
6. Position re-location on the table-top.

7. Position re-location on the field.
8. The detection of the Curvature of Curbs.
9. Emotional Factors Inventory (3) and Taylor's Manifest Anxiety Scale (15).
10. Wechsler Adult Intelligence Scale (Verbal Section (17)).

Procedures for the administration of these tasks will be described on the following pages. Tasks 1 through 8 might be classified as perceptual-motor problems, or perhaps as problems involving perceptual judgments made through movement. Tasks numbered 9 and 10 are standard psychological measures, traditionally administered to the blind.

Test No. 1: Veering Tendency, Field.

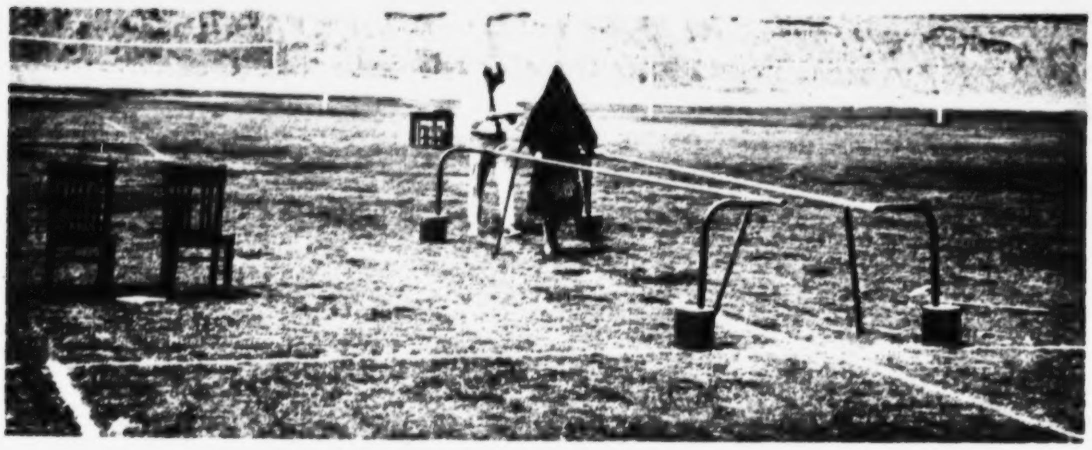
A large level athletic field was inscribed with chalk-lined squares 10 yards by 10 yards, so that the total gridded area encompassed 90 yards by 120 yards. Two starting points were designated mid-way along the two 90 yard edges of the field. These starting points were entered after the subject had passed through a pathway 20' long formed by two aluminum tubes 2" in diameter, placed 3' high, and 2' apart. (Plate 3).

After the subject had been seated in front of the testor, the following directions wrre read:

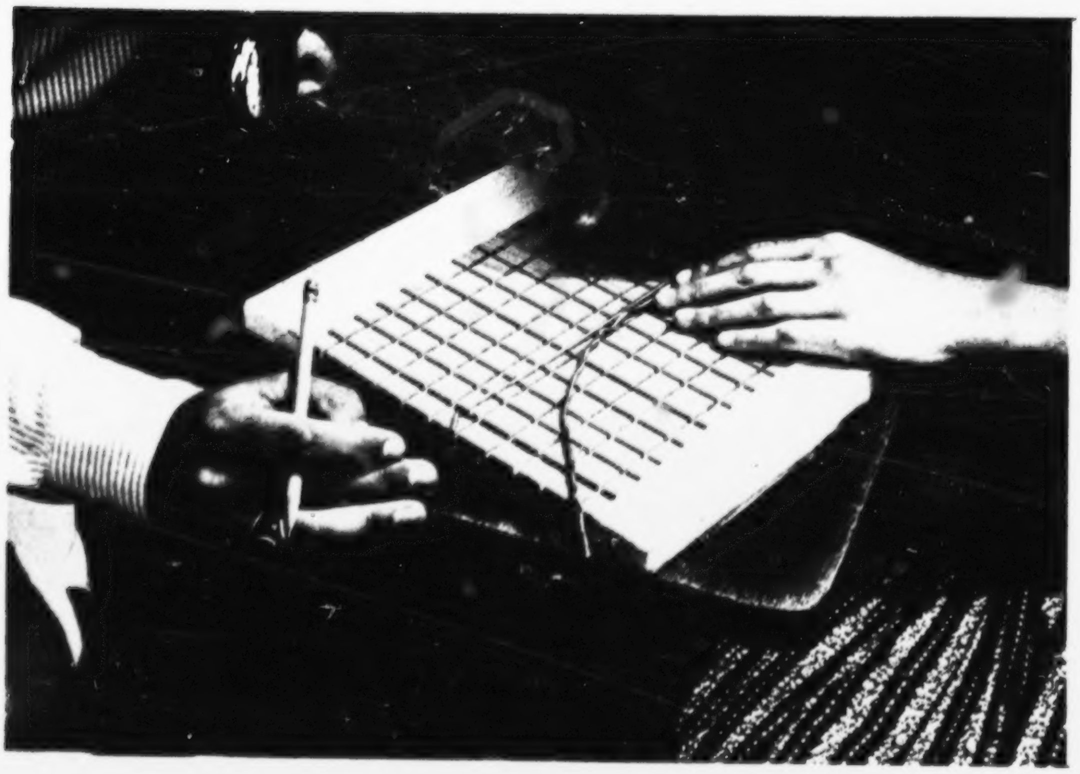
"We are now on a large level athletic field

Plate 3

INITIAL PATHWAYS USED IN EVALUATING THE VEERING TENDENCY



WOODEN GRID USED TO PROVIDE INFORMATION RELATIVE TO THE 'PATH' WALKED BY THE SUBJECT



free from obstructions and irregularities. It is about 120 yards by 120 yards in size. We will attempt to see how straight a path you can walk after first passing through a straight pathway twenty-feet in length, formed of aluminum tubes placed waist high and about 2' apart. After walking through this pathway you are to continue to walk, at your normal walking speed, in the direction originally established by the pathway. We will stop you when you have walked from 3 to 4 minutes. Having done this once, you will be given a short rest and then will proceed to a second trial. You will do this eight times in all. I (the experimenter). will be directly in back of you at all times to assist you if you feel any discomfort. You may use either both hands or one hand to guide yourself through the pathways. In order to reduce light, sound and wind cues, we will place two rubber ear plugs in your hands which you will insert into your ears. Cotton will be placed over these. In addition, a black hood will be placed over your head and shoulders for all of the trials. Do you have any questions?"

One-half of the subjects were designated as controls, and received eight trials on the task as outlined above. These trials were started in random order from both ends of the field. One-half of the subjects were designated as experimental subjects and were given the following additional information prior to the first traal.

"After you have finished your fourth trial we would like you to braille a miniature reproduction of the field, and by guiding your hands along a piece of flexible wire learn how you walked on this fourth trial. We want you to use this information as a basis for trying to walk a straighter path on subsequent trials. We will also provide you with this information after your 5, 6, and 7th trials."

After the above was read and the ear plugs were inserted, a hood was placed over the subject's head. He was then led to the initial end of the starting pathway and was started by saying "Are you ready? You may begin." One orienting trial was permitted through the starting pathway, prior to beginning the first trial. Care was taken to see that the subjects kept their hands inside the pathway's railings.

As the subject left the end of the starting pathway and entered the field, a stop watch was started by the experimenter, and the pathway walked by the subject was plotted on a smaller paper grid placed on a clipboard held by the testor. The subject was stopped after he had left the grid, or after he had completed a circle on the grid. When the subject was stopped the stop-watch was also stopped, and the time to the nearest 10th of a second was recorded. After each trial the subjects were led to a desk-chair by the "starting pathway" through which they were to begin their next trial.

The Experimental subjects, following trials 4, 5, 6, and 7 were seated at a desk upon which a wooden grid corresponding to the grid on the field was placed. The flexible solder wires were attached to the middle of the edge of the grid nearest the subject (Plate 3). The experimenter then gave the experimental subjects the following information:

"Before you is a copy of the grid on the field. Feel with your hands the grooves, these correspond to 10 yard squares on the field. Feel the straight wire (the subject's hand was guided along this wire), this represents the straight line you attempted to walk. Feel this curved wire (the experimenter bent one wire into a shape approximating the pathway the subject had taken on the previous trial), this is the pathway you actually walked."

The subject was then given two minutes to inspect this grid-wire arrangement, and any questions which related to the scale, shape of the pathway walked, etc. were answered. No information was given concerning any prior trials other than the one just completed.

After the subject performed eight trials their ear plugs and hood were removed and they were taken to the next testing area. For specific scoring procedures, see Reference 5.

Task No. 2: Veering Tendency, Gymnasium.

An area 60' x 100' was laid out in the gymnasium. Subjects were again initially guided in starting to walk a straight line by 20' aluminum pathway identical to those used in Task #1. The pathway intersected the middle of the 100 feet edge in this area, so that the subjects walked, if they proceeded in a straight line, about 60 feet straight ahead before crossing a 100 foot tape. The experimenter recorded the point (to the nearest foot) at which the subject intersected the tape.

The directions given to the subjects were identical with those given on the field, with the exception that it was explained that they were in a a gymnasium, and that thet would walk about 30 or 40 yards before being stopped. The experimental subjects were told that the wooden grid they felt was gridded with squares which were 10 feet instead of 10 yards on each side, and the flexible wires were carefully adjusted to give the subject an accurate account of how much he had veered at 60 feet, i.e. 6 squares away form the starting point. The subjects who were designated as control subjects remained control subjects in both the field and gymnasium veering tasks; experimental subjects likewise remained in the experimental group in both situations during both days of testing. The subjects' walking-speeds were also clocked to the nearest tenth of a second in the gymnasium.

Task No. 3: Perception of the Lateral Tilt in Pathways Walked.

The apparatus for this testing consisted of four risers 16 feet long, 4 feet wide, and from 12 to 18 inches high. These risers were made of 3/4th inch reinforced plywood and were peaced in a large, level gymnasium. Each riser had two steps at the 4 different foot ends to enable easy descent and ascent. They were placed in a radiating pattern so that each riser was in the middle of a side of an 8' square laid out on the gymnasium floor. The risers were constructed with 0 (level), 1, 2, and 4 degrees of tilt. After the subject had been seated in a chair near the apparatus the following instructions were read:

> "You will be asked to walk along a number of short pathways consisting of risers 16 feet long and about 1 1/2 ' high. Some of these pathways will tilt to the left, others will tilt to the right and others will be level. This tilt will not be great enough at any time to cause you to fall. You will be guided at the side by the elbow as you walk. As you walk each riser, please report, as soon as you can, whether you feel the risers tilting to the left, to the right, or level. Please report any tilt you feel even though it may be slight. Are there any questions?"

After questions were answered, the subject was led to the initial riser, helped to mount it via the stairs and was guided across it by an experimenter. A second experimenter recorded the subject's responses. The risers whose surfaces were tilted at 1, 2, and 4 degrees were each traversed four times subsequent to an initial orienting trial on the level riser. The level riser was traversed twice.

All risers were traversed in a random order to reduce the influence of possible after-effects upon the subjects' judgment. Pilot studies demonstrated that cues obtained from the experimenter's efforts to guide the subjects did not influence the judgments made, and care was taken to alternate the "guide " elbow from the "downhill" side to the "uphill" side of the subject.

Test No. 4: The Accuracy of Facing Movements.

The apparatus consisted of a large protractor, marked off in degrees and nailed to the floor. The subject stood in the center of this pootractor in a circle 18" in diameter bounded by a metal edge 4" high. A leather belt from which extended a wooden pole 1" in diameter was worn by the subject. The pole extended directly to the front of the subject and was parallel to the ground. A string with a plumb-bob was attached at the distal end of this pole. (Plate 2). Thus the angular turn made by the subject could be determined to the nearest degree by comparing the initial and final positions of the plumb-bob. The apparatus was placed in the center of a room 30' by 30'.

All the subjects participated in this task during both testing days. During the second day of testing one-half of the subjects received brief practice prior to attempting the task.

After the subjects were seated they were instructed as follows:

> "The purpose of this task is to see how well you can accurately position your body in space by turning it in different directions while standing. We want you simply to turn your body in different directions when we ask you to. You will be hooded, and your ears will be plugged, and belt placed around your waist. You will then be taken to the center of a large protractor and be asked to make one-quarter, one-half and full turns to the left and to the right. You will make 12 turns in all. When you make your

turn please keep the heels and balls of your feet in contact with the floor at all times, thus executing a kind of shuffle turn. Please do not make a military facing movement. Do you have any questions?"

The subjects were then ear plugged and hooded, and the belt was placed around the waist. They were led to the testing room, and the the center of the protractor. The subject was started at 0 degrees on the protractor. Each subsequent turn was made from the ending point of the previous turn. Following each turn the experimenter recorded to the nearest degree, the point at which the subject stopped. The subjects reported the inability to hear any noises except the directions given to them by the experimenter. Following the 12th trial the subjects were aided in stepping out of the center of the protractor, and the hood, ear plugs and belt were removed.

The experimental subjects, consisting of one-half the subject population during the second testing session received brief practice prior to being re-tested on this task. They were informed that they would receive a brief training period prior to performing the test this second time. This training consisted of the following:

"The first (next) turn I want you to make is a 90 degree (180, 360) or quarter turn (half, full) to your right (left)." (Subject is permitted to turn). "I asked you to turn 90 degrees to the right. You turned (stated degrees actually turned), which was (stated) degrees (over or under). Let me show you where you should have stopped." (The experimenter guided the subject from behind with both hands at the waist until the subject moved to the point where he should have stopped). "So you (over or under) turned by (stated) degrees." This training procedure was carried out for both left and right runs of 90, 180, and 360 degrees prior to testing experimental subjects on the second day."

After the training session was completed the experimenter said to the experimental subjects:

"I am now going to ask you to perform a series of these same kinds of turns that we have been performing, except that now I'll give them to you in a random order, and will not tell you any thing more about the accuracy with which you have turned. Try to use the clues I gave you before and make these turns as precisely as you can. Do you have any questions?"

The 12 facing movements were then administered to the experimental group as previously described. Following the completion of these turns, the subjects were led from the testing area.

Task No. 5: The Veering Tendency of the Arm.

The apparatus and equipment consisted of a chair and table whose heights were 18" and 31" respectively. 16" x 16" graph paper (5 squares per inch) was secured to the table. A cardboard starting groove 1" in width intersected the near edge of the grid. This groove was used to aid in initiating the subject in starting to draw the straight line. Guide lines parallel to the edge of the table drawn on the floor facilitated the correct positioning of the chair.

The subject was positioned so that the center of his sternum was 6" away from the starting groove. Two trials, randomly ordered, were given for each hand. The pencil was held between the thumb and fore finger with the middle finger guiding it lightly (as for handwriting). Deviation from the straight line was measured to the nearest tenth of an inch at 5 and 10 Inch distances from the near edge of the graph paper. (When the subject was finished drawing the four lines, he was then taken to his next testing site).

After the subject was seated before the experimenter, the following information was read:

> "We are interested in seeing how accurately you are able to draw a straight line directly away from your body. You are now seated before a table, and should make a line so that it makes a 90 degree angle with its near edge. There is a short groove in the center edge of the table in which you will place your pencil to help guide you when beginning to draw the straight line.
>
> Feel the straight edge of the table (subject's hand is guided along the near edge of the table), position yourself so that you are facing the table squarely. (Chair was also positioned by the experimenter using the guide lines drawn on the floor, parallel to the edge of the table.) When you are drawing your lines please keep your back against the chair and your free hand in your lap. We'll do the first trial with the left(right) hand. Now feel the groove in the center of the nearest edge (subject's hand was placed on the groove). I will help you place your pencil in the groove, and then you attempt to draw a staaight line directly away from the center of the body, following the straight line originally established by the starting groove."

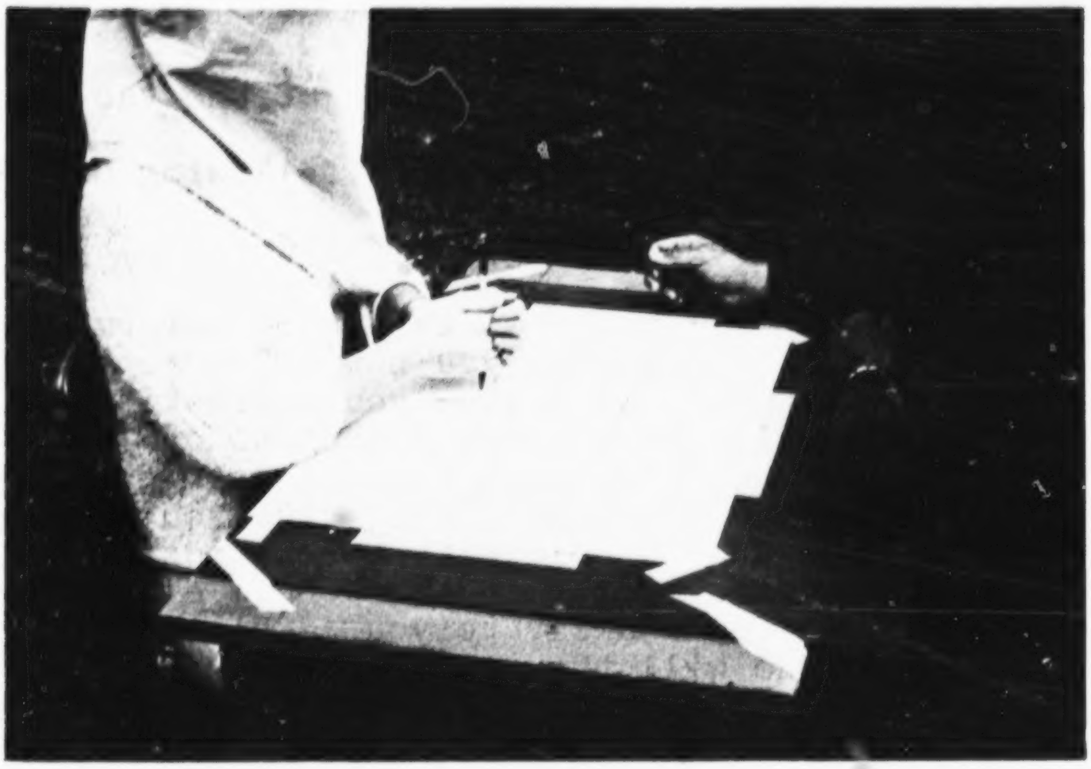
Task No. 6: Position Re-Location, Table.

The position re-location task was given in two parts: a limb re-positioning task using a table-top and a body re-location task using a portion of the athletic field adjacent to the veering station. For convenience, the table-top was also located on the field.

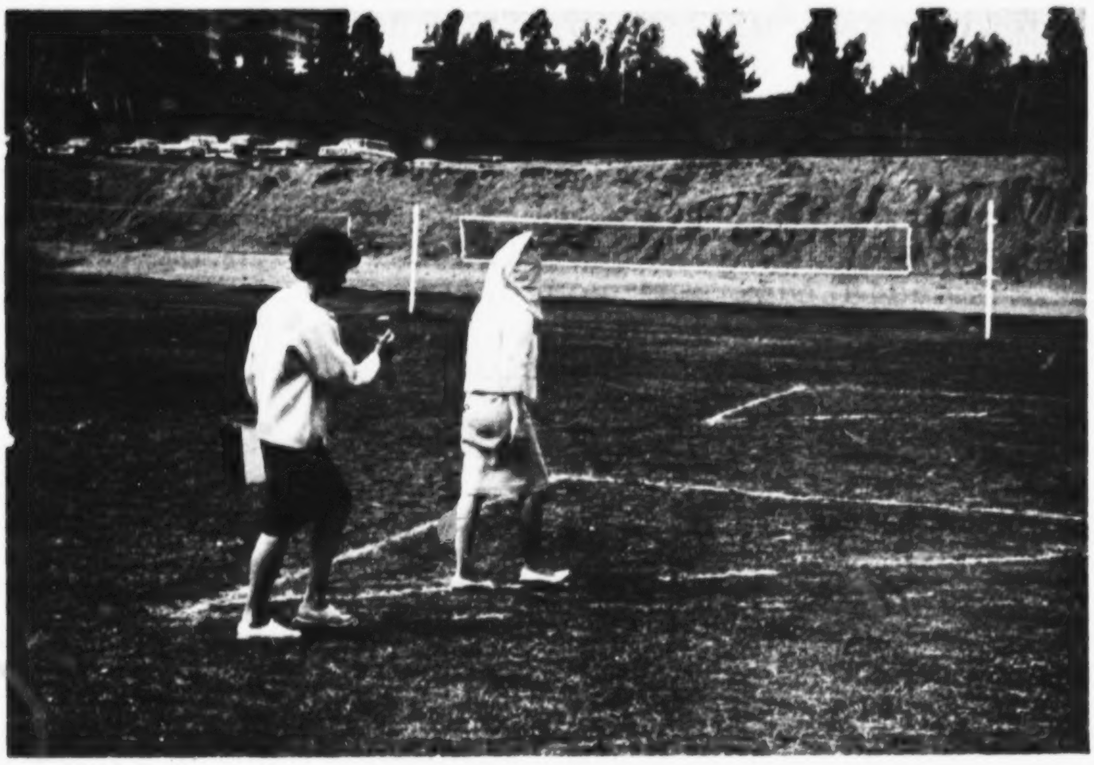
For the table-top task the subjects held one pencil in both hands using an over-lapping grip. From a starting position their pencil was then guided over the legs of an isoceles right triangle with a hypotenuse of eleven inches. The subjects attempted to re-locate the starting position by returning along the hypotenuse of the triangle. The hypotenuses of the triangles were not actually drawn; only the legs were drawn so that the testor could guide the subject's hand away form the starting position in a uniform manner. The legs of the triangles were arranged so that they formed a "T" shape with the leg of the "T" pointing toward the subject. The bottom of the "T" was the starting position where the point of the pencil was placed (Plate 4). This point was located three and one-half inches from the edge of the table. The subjects were seated so that the sternum was two inches away form the edge of the table and the starting point was in line with the center of the sternum. The subjects were required to keep their

Plate 4

TABLE-TOP POSITION RELOCATION TASK



POSITION RE-LOCATION TASK: FIELD



backs against the chair thus assuming that only their arms and hands were used in performing the task.

Since the administration of the table-top and field tasks was similar, the following directions were first read to all the subjects:

> "You will have two tasks to perform. I will explain both tasks to you now. Before you do each task the testor will give you a practice trial so that you will know exactly what to do.
>
> For the first task you are going to be seated at a table. The testor will give you a pencil which you are to hold with both hands. The testor will place the point of the pencil at a spot on the table-top and say to you ' this is your starting point.' He will then lead your hands straight out from you and make a sharp turn to the left or to the right. When he releases your hands you should then try to return directly to the starting point.
>
> For the second task a black hood will be placed over your head and you will be walked to a starting point. The testor will stop you and say 'this is your starting point.' He will then guide you in a straight line away from the starting point and after a short walk will make a sharp turn either to the left or to the right and guide you again in a straight line. He will stop after a short walk and release you. You should then turn around and walk directly back to the starting point and stop. You will be walking the same pattern you drew on the table.
>
> During the walking task a testor will be directly in back of you at all times to provide for your safety. If you experience any discomfort, let us know immediately, and you may stop. Any questions?"

After the directions were read, the subjects were asked to place rubber plugs in their ears and to cover these with cotton. All the subjects were blindfolded; The blindfold held the cotton in place. Each subject was then taken to the table-top and given a practice trial on a triangle which was smaller than the testing triangle (hypotenuse = 4"). The testor explained the procedure as he guided the subject's hand along the legs of the triangle and back to the starting position. If the subject did not understand, another practice trial was administered.

Each subject was given a total of four trials; two trials returning on an hypotenuse to his right and two on the hypotenuse to his left. Each subject took two trials using the hypotenuse to one side and then two trials using the hypotenuse to the other side. The left-right order was alternated across subjects. Scoring consisted of the absolute amount of deviation in inches from the original starting point.

Reliability of the table-top and field tasks was determined by the Pearson Product-Moment correlation formula. The reliability coefficients for the table-top task are as follows: Left-Hypotenuse Return: .80; Right-Hypotenuse Return: .57. For the Field Position Re-Location Task: Left-Hypotenuse-Return: .71; Right-Hypotenuse-Return: .70.

Task No. 7: Position Re-Location, Field.

Immediately following the table-top task the body re-location task was administered. All subjects remained ear-plugged. A portion of the level field adjacent to the veering station was used for the body relocation task. Four isosceles right triangles with hypotenuses of twenty-two feet were lined on the grass field. The triangles were spaced 20' apart so that two subjects could be tested at once. To eliminate feedback, two triangles requiring a right hypotenuse return and two requiring a left hypotenuse return were alternated. For the right hypotenuse the subject was given a starting position, guided away from it in a straight path on one leg of the triangle, turned 90 degrees to his right and guided along the other leg of the triangle. When the testor released the subject he was instructed to "turn to the right (left) and walk directly back to the starting position" (via the hypotenuse). The procedure for a "left" hypotenuse return was the same except the 90 degree turn was to the left (Plate 4).

In addition to the general directions read prior to the table-top task, each subject was given a practice trial on the field on a triangle which was smaller than the testing triangles (hypotenuse = 6'). The testor explained the procedure as he guided the subject along the legs of the triangle and back to the starting position. If the subject did not understand he was given another practice trial.

The subjects on the field were guided by holding on to the testor's elbow as he walked the pattern. The subject walked on the chalk lines, while the testors walked on the outside of the triangle. When the subject was released he was told to turn (either left or right) and to walk directly back to the starting position. When the subject stopped, thus indicating that he perceived he was at the starting position, a marker was placed equidistant between his heels. The distance from the marker to the actual starting position was measured to the nearest one-half foot.

Each subject was given a total of four trials' two trials returning on the right hypotenuse and two on the left hypotenuse. Each subject received two trials using the hypotenuse to one side and then two trials using the hypotenuse to the other side. The order was alternated by the subject.

In addition to the table top and field tssks, one-half of the subjects, an experimental group, received training on the table-top task. Each subject attempted four times to relocate a starting position as in the original table-top task. During this training period, the testor took the subject's hands and guided them to the correct starting position, and after each trial explained how much the subject had deviated foom the original starting point.

He was then taken immediately to the field and received two re-location trials using the same hypotenuse side return as had just been employed in the previous table-top training task. This training process was repeated using the opposite hypotenuse return so that each experimental subject was trained for both the right and left hypotenuse returns.

The remaining subjects, a control group, received no training on the table-top task. The controls waited five minutes after completing the field task the first time and then repeated the field task again.

Task No. 8: Perception of the Curvature of Curbs.

As a result of pilot studies (Chapter II) it was decided to use "curbs" having the following radii: 5, 10, 15, and 30 feet. The straight side of these curbs was 6 feet in length; the curved side was a quarter of a circle whose radius varied as listed above. Each curb was 18" thick and could be attached one at a time to a platform of similar thickness, 4' x 4', upon which the subjects stood. Testing was carried out in a small classroom. The canes utilized were either ones owned by the subjects, or aluminum canes, 5' or 5'6" in length, provided by the experimenter for the subjects who did not have their own (Plate 1).

When the subject was seated comfortably in front of the experimenter the following information was read:

> "In this next task we are interested to see when you are able to tell a straight curb from a curved one. To perform this task, you will stand on a large 4" x 4" platform about 18 inches high. I will help you onto this platform. You may then "braille" it with your cane so that you will become familiar with its size, shape, etc. We will attach the curbs to the edge of the platform and then ask you, using a cane in any manner that you wish, to braille the various curbs and report to us whether they feel straight or curved. You may take as much time as you need in order to make your decision. Simply report to us 'straight' or 'curved' once you have decided. The curbs will be attached to two different sides of the platform. Therefore, you will be asked to move alternately back and forth across the platform. The experimenter will always help you in your movement back and forth across this platform. Do you have any questions?"

If the subject did not have his own cane, one was provided. The height of this cane was made to equal, as near as possible, the distance from the arm-pit of the subject (when standing) to the floor. The subject was then assisted in mounting the platform, and with his cane was aided in determining its general size and shape. The curbs listed, plus a straight curb, were attached to the platform in a random order. When the curb was in place the experimenter said:

> "Braille this curb and tell me whether it is straight or curved. Take as much time as you like."

After this was done, the subject was instructed to make an "about-face," and the second curb was attached to the platform. Each curb was presented for his inspection twice, a total of 10 trials. A second testor recorded the subject's responses.

Task No. 9: Emotional Factors Inventory - Taylor's Test of Manifest Anxiety

The Emotional Factors Inventory is designed to measure various facets of the emotional make-up of the blind. Questions purporting to evaluate such qualities as sensitivity, attitudes toward blindness, feelings of distrust, and Social Competency are included. The questions for this test were placed on tape, each question was repeated twice, and yes-no answers were indicated by the subjects by placing cards, numbered to correspond to the questions asked, in an appropriate box. "Yes" answers were placed in a box on the subject's right and "no" answers in a box on the subject's left. Testors, observed the number on the cards placed in the boxes after each question was asked and transferred the responses to standard answer sheets.

After the subjects were seated (5 subjects were tested at a time) the following instructions were read to them:

"I am going to read to you a number of questions, and I want you to answer these questions thoughtfully. I will read each one twice so that you will have plenty of time to think about your answer to the statement. Before each of you are two small boxes secured to the table, one on the right and one on the left. Will you find these boxes on the table so that you know exactly where they are? The assistants I introduced to you will give you a stack of ten (10) cards each. These cards are numbered and correspond to the first ten statements I will read. If your answer to the question is "yes," place the card for that question in the box on the right. If your answer is "no," put the card in the box on the left. Some of the statements you may find difficult to answer in relation to yourself, but try to answer as best as you can. When we have completed the first 10 questions, the girls will give you a second stack of 10 cards for the next 10 questions. We will proceed in this manner until we have completed all of the questions, about 140 in all. You may have as much time to think about these questions and answers as you like. If you want me to repeat any of them, I will do so. Do you have any questions?

If a subject indicated that he misunderstood a question, or required more time, the tape was stopped and the question, repeated by an experimenter. At the completion of these 140 questions, 20 additional questions were asked which purport to evaluate anxiety on the scale developed by Janet Taylor (15). Thus the tape contained approximately 160 questions. Following the administration of these tests the subjects were taken to another testing area.

These two tests were administered in order to describe the emotional make-up of the total subject population, and to assess the possible influence of high anxiety and/or emotional imbalance upon the perceptual-motor measures obtained. Reliability of these two measures has been established by the respective authors. (3, 15).

Task No. 10: The Verbal Portion of the Weschler Adult Intelligence Scale.

The verbal portion of the WAIS was administered individually to each subject. From three to five qualified testors were available each day, and consisted of clinical psychologists all certified to administer this evaluative device. This test also was administered in order to better describe the population being tested and to identify the influence of extremely high or low intelligence upon the execution of other experimental tasks.

ANALYSIS OF THE DATA

Although it is obvious that innumerable relationships might be elucidated by a detailed examination of the vast amount of data collected, it was decided to be selective rather than present an exhaustive treatment of many trivialities. Therefore the analysis and results found in the following chapter primarily include data in which the subject population has been treated as a whole, rather than presenting scores analyzed by age, sex, etc. Crucial information, it was believed, centered around the influence of the brief training programs upon the measures obtained; the threshold to the perception of tilt; the accuracy with which the subjects were able to execute facing movements; and the relationship of the two table-top tasks (arm veer, and position re-location) to the corresponding tasks performed on the field. Description of specific analyses are included under the Results Section for the various tasks.

CHAPTER IV
DATA, ANALYSIS AND FINDINGS

Introduction.

The findings are presented in the following format: (a) a general description of the subject population in terms of age, number of years blind, I.Q., and personality or emotional characteristics; (b) results of specific analyses of the Veering Tendency, Perception of Tilt, Facing Movements, Position Re-Location (field and table-top), Veering Tendency of the Arm, and Perception of the Curvature of Curbs; (c) Selected interrelationships between the various performance measures where not presented previously.

Subject Population.

Although 55 subjects originally indicated by mail their willingness to participate in the project, a total of 45 subjects were tested during the initial data collection session. 43 of these 45 subjects participated in the second week of testing in April. Two of the subjects were unable to attend this second session due to ill-health.

Of the total 43 subjects upon whose scores the primary analyses were based, twenty were women and 23 were men. These subjects ranged in age from 17 to 45 years, average age 31.86 years (s.d.=11.8).

Forty-five percent (45%) of the subjects were blind from birth; the remainder were adventiciously blind. The most prevalent cause of blindness in those who reported being blind from birth was RLF (retrolental fibroplasia), while diabetes was the predominant cause of blindness in those adventiciously blind. The mean age at which the adventiciously blind had gone blind was 25.3 years, and on the average, these individuals had been blind for 10.4 years. 45% of the subject population were totally blind; 55% had partial vision.

The average I.Q. of the subjects (based upon scores obtained from the Verbal Portion of Wechsler Adult Intelligence Saale, WAIS) was 115 (s.d. 13.5). The distribution of these I.Q. scores is shown in Figure 3. This distribution suggests that the blind population involved in this project was, for the most part, above average in intelligence with sixty-five percent (65%) of the subjects having an I.Q. above 110. (Specific interrelationships between I.Q. and various other performance measures are found in the final section of this chapter.

Results of Bauman's Emotional Factors Inventory are shown in Figure 4. As can be seen, the majority of all the subjects scored well below the 30th percentile (the lower the percentile the better the adjustment) on all of the Subscales thus indicating a generally high level of adjustment on the part of the subjects.

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FIGURE 3

DISTRIBUTION OF SCORES ON THE VERBAL SECTION OF THE W.A.I.S.

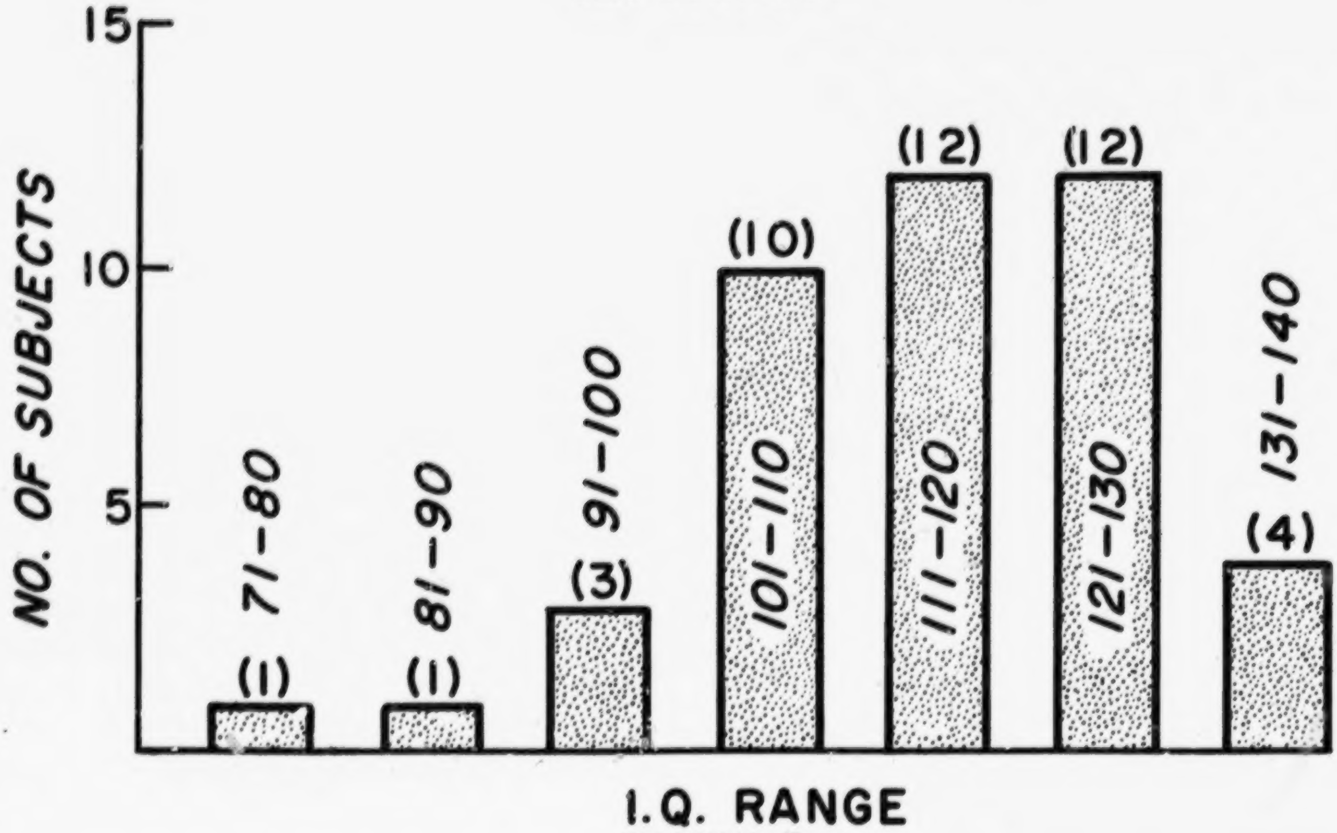


FIGURE 4

AVERAGE PERCENTILE RANKING ON BAUMAN'S EMOTIONAL FACTORS INVENTORY

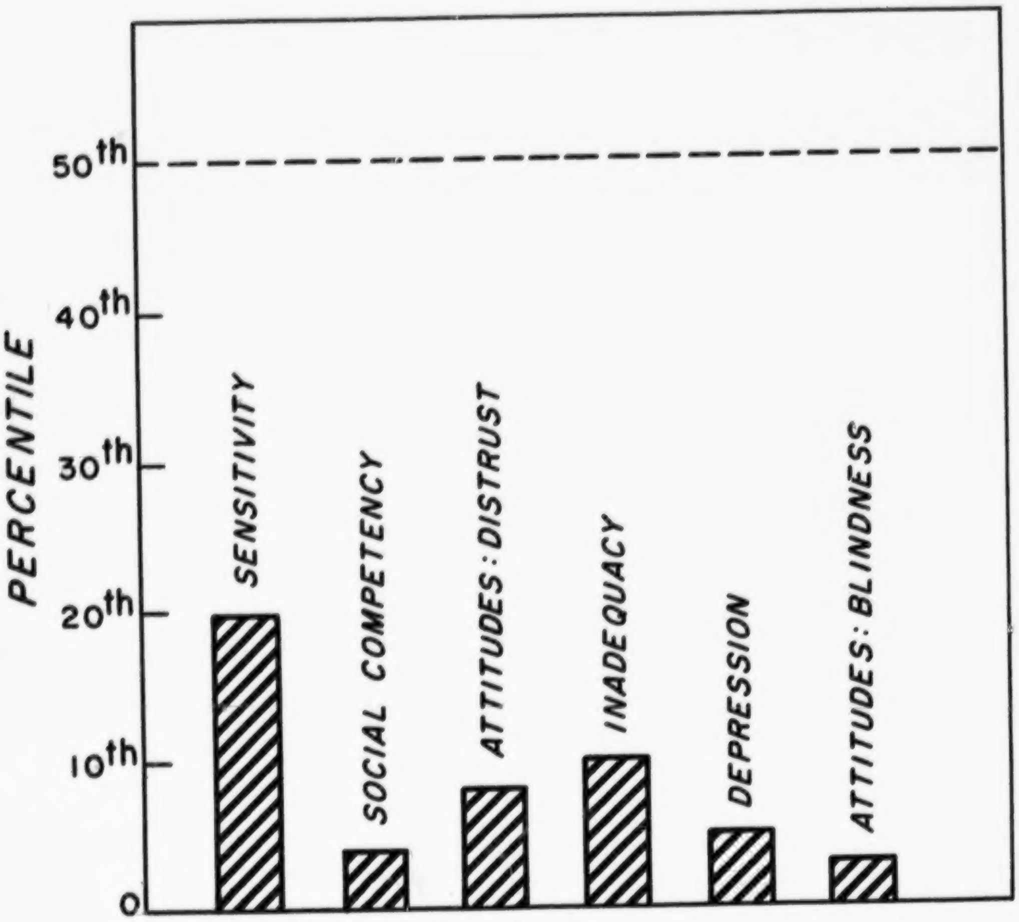
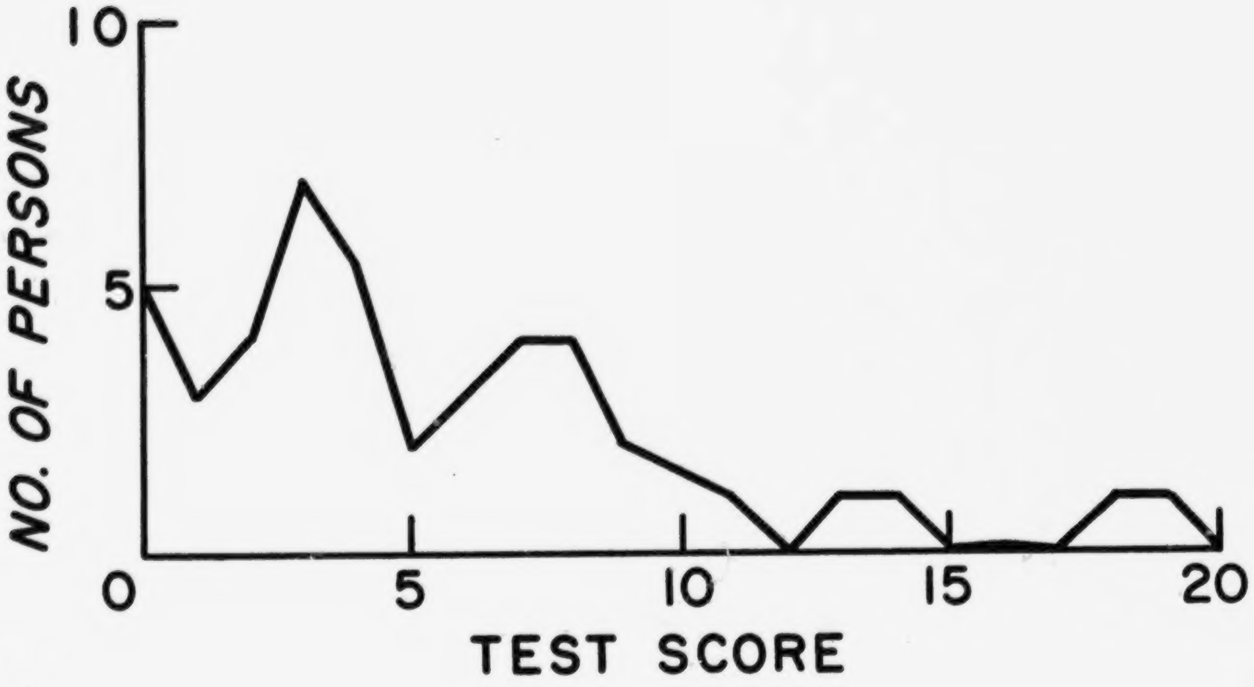


FIGURE 5

DISTRIBUTION OF SCORES ON TAYLOR'S TEST OF MANIFEST ANXIETY



Scores obtained from the administration of Taylor's Scale of Manifest Anxiety corroborated the data obtained from the Emotional Factors Inventory (Figure 5). The mean score obtained was 5.2 (s.d.= 4.4.). Since a high score on this test (15-20) indicates a high level of anxiety, these data suggest that the subjects, for the most part, could be classified as individuals with low levels of anxiety.

In summary then, these data indicate that the subject population involved in this project was above average in intelligence,emotionally stable, and relatively free from anxiety.

RESULTS OF ANALYSIS OF INDIVIDUAL TESTS

The Veering Tendency

Direction of Veer. The analysis of the direction of veer was based upon a compilation of all subjects prior to the introduction of 'tactile feedback' to the Experimental subjects. The criterion for 'consistency' in direction of veer was that the subject veered in the same direction 75% of the time or 3 out of 4 trials.

Of the 36 subjects having four initial trials in the gym, 33 or 91.7 % were consistent veerers, veering 75% of the time in the same direction. Of the 41 subjects who received four trials on the field initially, 33 or 80.5% veered consistently in the same direction.

When the performances of the 22 Control subjects are considered separately, 77.3% or 17 veered consistently to the same side in the gymnasium while 68.2% or 15 veered in the same direction when asked to walk a straight line on the field. When the performances of the control subjects on both the field and the gym are combined to get an overall picture of the consistency of the direction of veer, it is noted that 54.5% veered consistently in the same direction (i.e. they veered 12 or more trials out of a possible 16 trials in the same direction.)

A Chi Square test of Independence was employed to determine whether or not consistency of veering on the field was related to consistency of veering in the gym. The probability that the distribution observed was due to chance was .01, (X2 = 5.86, df =1), indicating that a subject who was consistent in his direction of veer on the field was also consistent in his direction of veer in the gym. Overall 53.7% of the subjects veered to the right when walking on the field; 46.2% veered to the left. In the gym, 51.1 % veered to the right; 48.1% to the left. A second Chi Square test of Independence was used to assess the relationship between direction of veer in the gym and the direction of veer on the field. (See appendix for these data.) Results here indicated that the direction of veer observed when a subject walked in the gym was independent of (i.e. not related to) the direction of veer observed when that same subject walked on the field. (9 = x^2).

In summary, a given individual may not veer in the same direction on the field as in the gym but, in general, he is consistent in the direction in which he veers on a given testing site.

Amount of Veer. The average amount of veer (all subjects) at 100' on the field was 21.66'; the mean deviation at 200' was 64.99'. (Figure 6) The average amount of veer (all subjects) in the gym at 60' was 8.11'. Figures 7 through 11 represent other specific findings related to the 'veering' tendency.

The results of a comparison of the amount of veer evidenced by all subjects (trials 1-4) on the field and the amount of veer evidenced by these same subjects when walking in the gymnasium indicated no significant differences in the veering accuracy at the two sites (Table I). That is, individuals tend to veer about the same amount whether walking in the gymnasium (mean veer at 60' = 8.29') or traveling on the field (mean veer at 60' = 6.30'). This indicates that the walking surface did not, in this instance, influence the accuracy with which an individual was able to walk a straight line.

FIGURE 6

THE MEAN VEER OF ALL SUBJECTS
On THE FIELD: FIRST FOUR
TRIALS

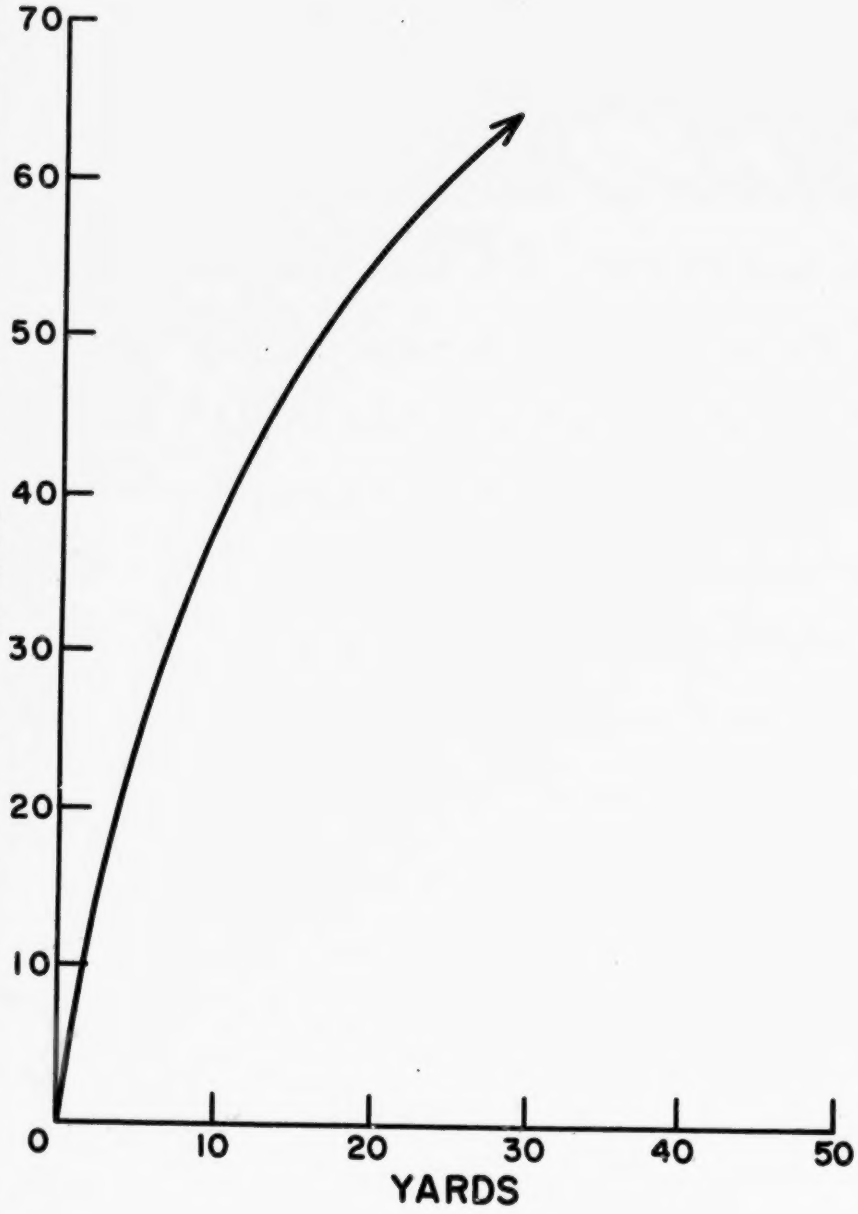


FIGURE 7

COMPARISON OF LEFT AND RIGHT
VEERING PATTERNS IN THE GYMNASIUM
AND ON THE FIELD: CONTROL SUBJECTS
FOR ALL EIGHT TRIALS

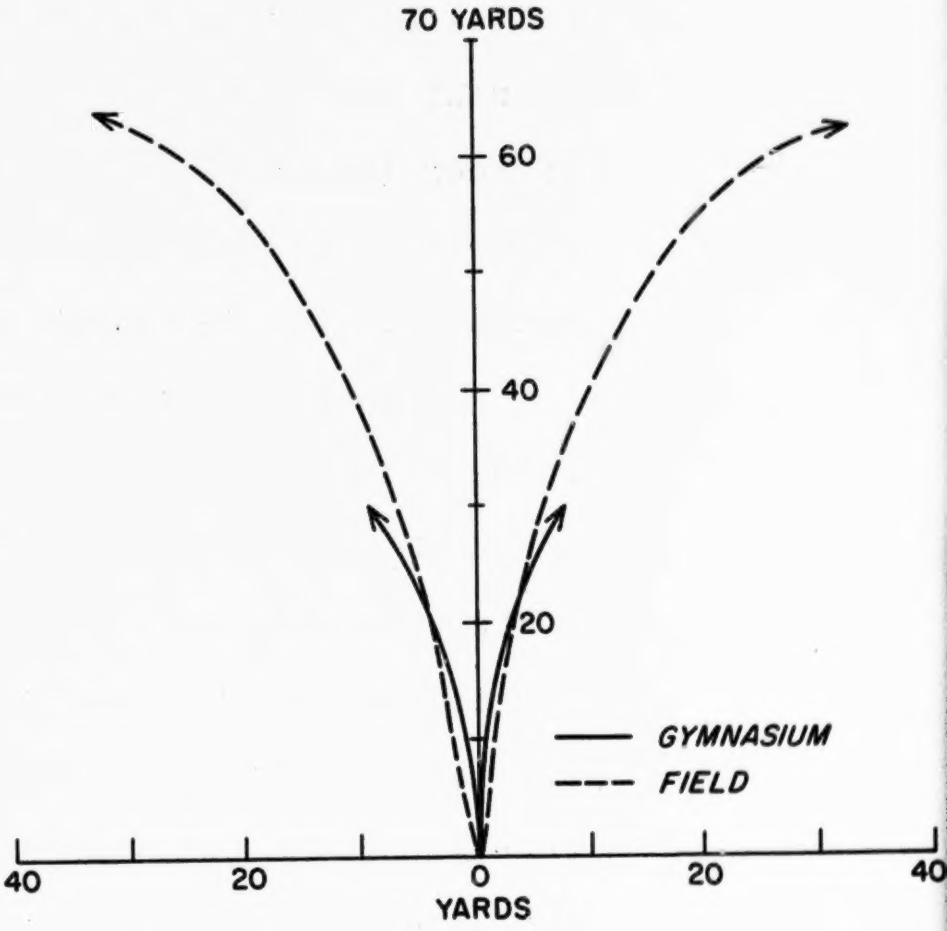


FIGURE 8

COMPARISON OF MEAN VEER ON THE FIELD BY CONTROL AND EXPERIMENTAL SUBJECTS: TRIALS FIVE TO EIGHT

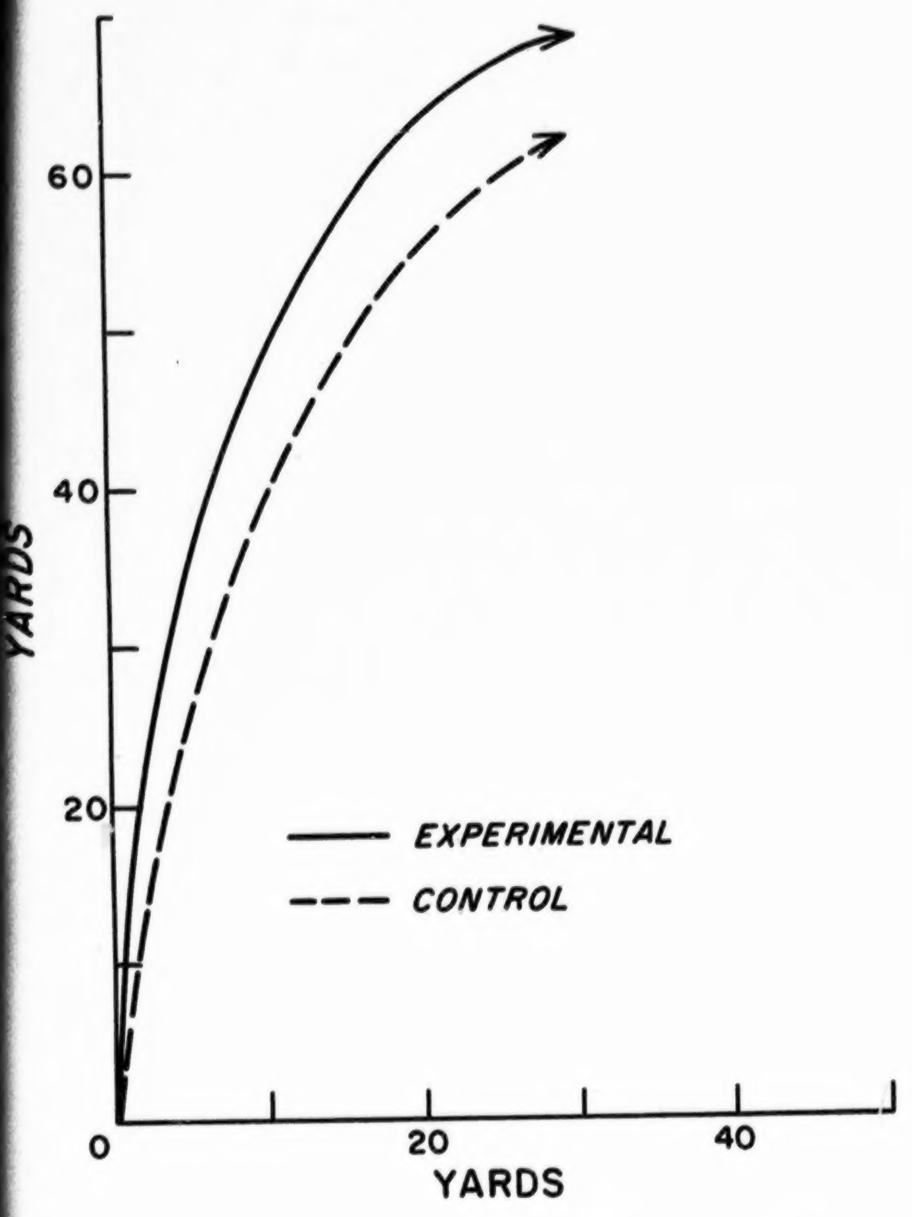


FIGURE 9

COMPARISON OF MEAN VEER IN GYMNASIUM BY CONTROLS AND EXPERIMENTAL SUBJECTS: TRIALS FIVE TO EIGHT

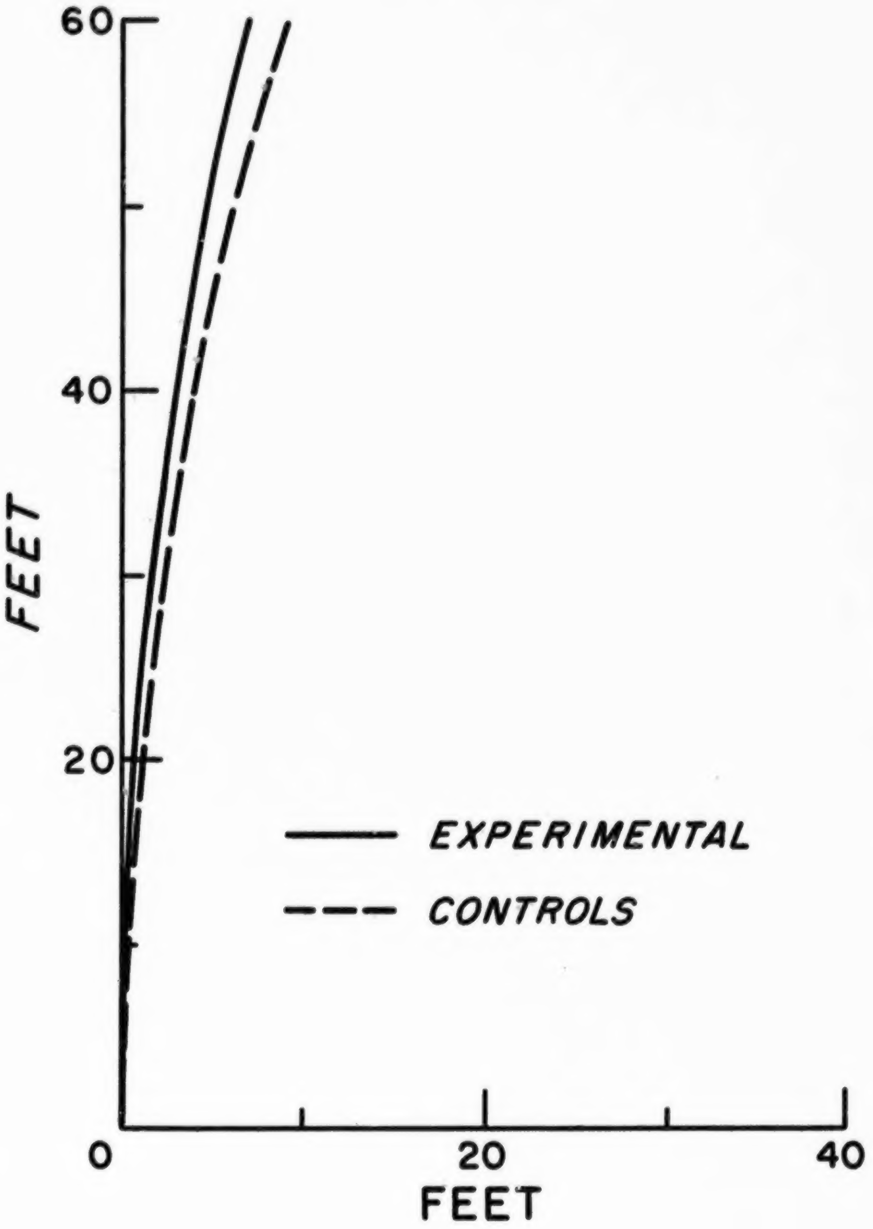


FIGURE 10.

MEAN VEER OF CONTROL SUBJECTS ON THE FIELD: TRIALS ONE TO EIGHT

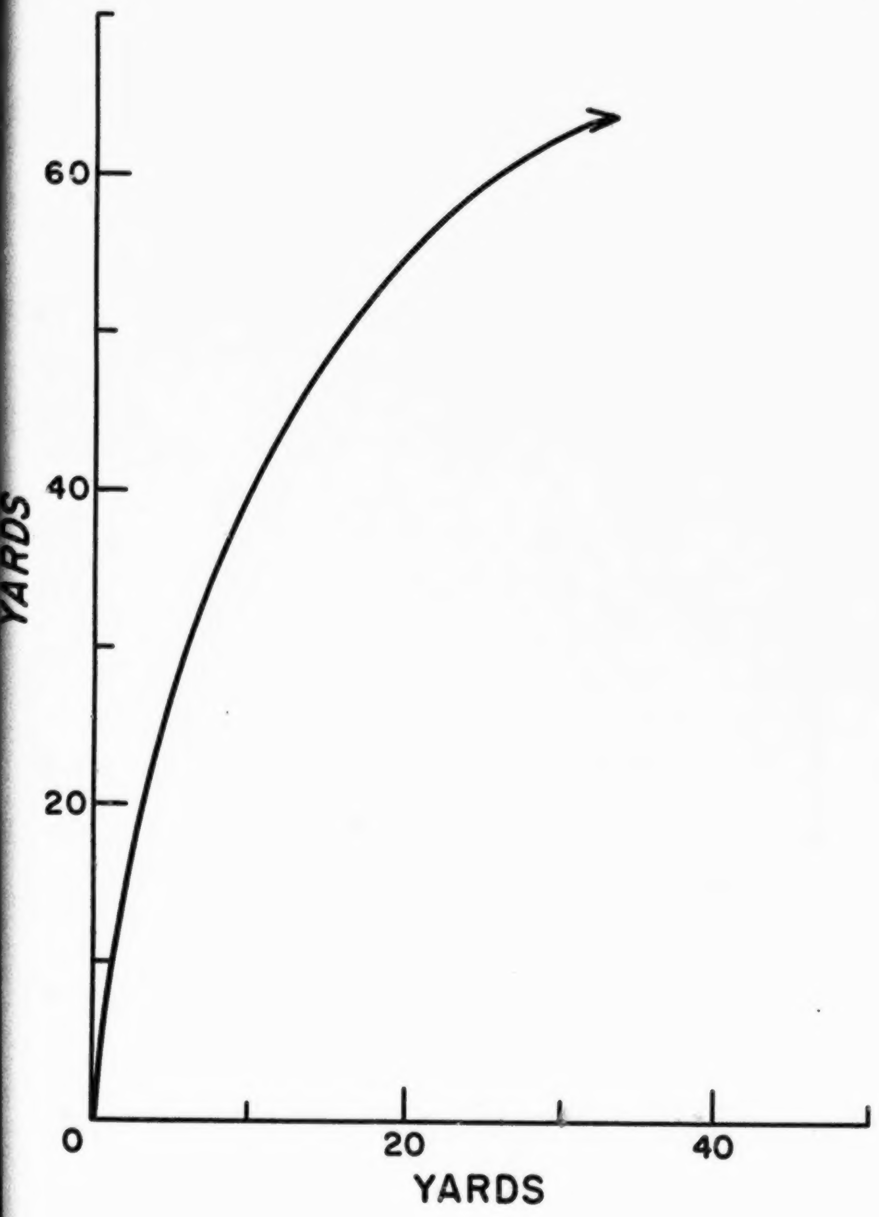


FIGURE 11.

COMPARISON OF MEAN VEER OF EXPERIMENTAL SUBJECTS: TRIALS ONE TO FOUR, AND TRIALS FIVE TO EIGHT

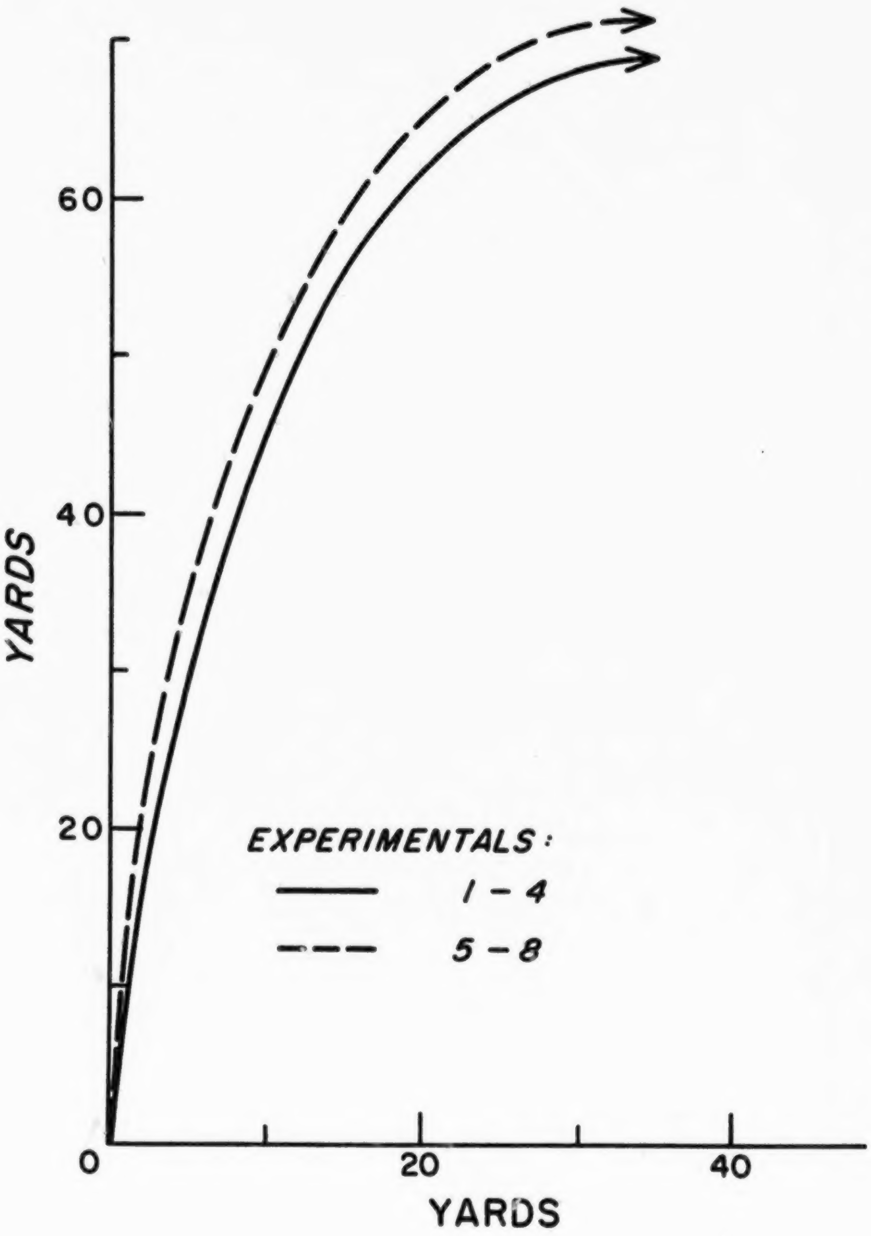


Table I

Comparison of the Amount of Veer in the
Gym vs. the Amount of Veer in the Field

	$\overline{X}$	$\overline{X}_D$	S^2_D	N	T-VALUE
Amt. Veer: Gym (60')	8.24'	1.94'	1.22'	42	1.76
Amt. Veer: Field (60')	6.30'				

Effect of Brief Training on Veer. Initially the Experimental ('Trained') and Control ('Untrained') groups were compared to determine whether or not the two groups were significantly different in terms of amount of veer prior to the introduction of the training conditions. T-tests comparing the amount of veer of the two groups at 100' and 200' on the field indicated no significant differences between the two groups before training. (see table II).

Table II
Veering Tendency: Comparison of
Experimental versus Control Groups
Before Training (Trials 1-4)

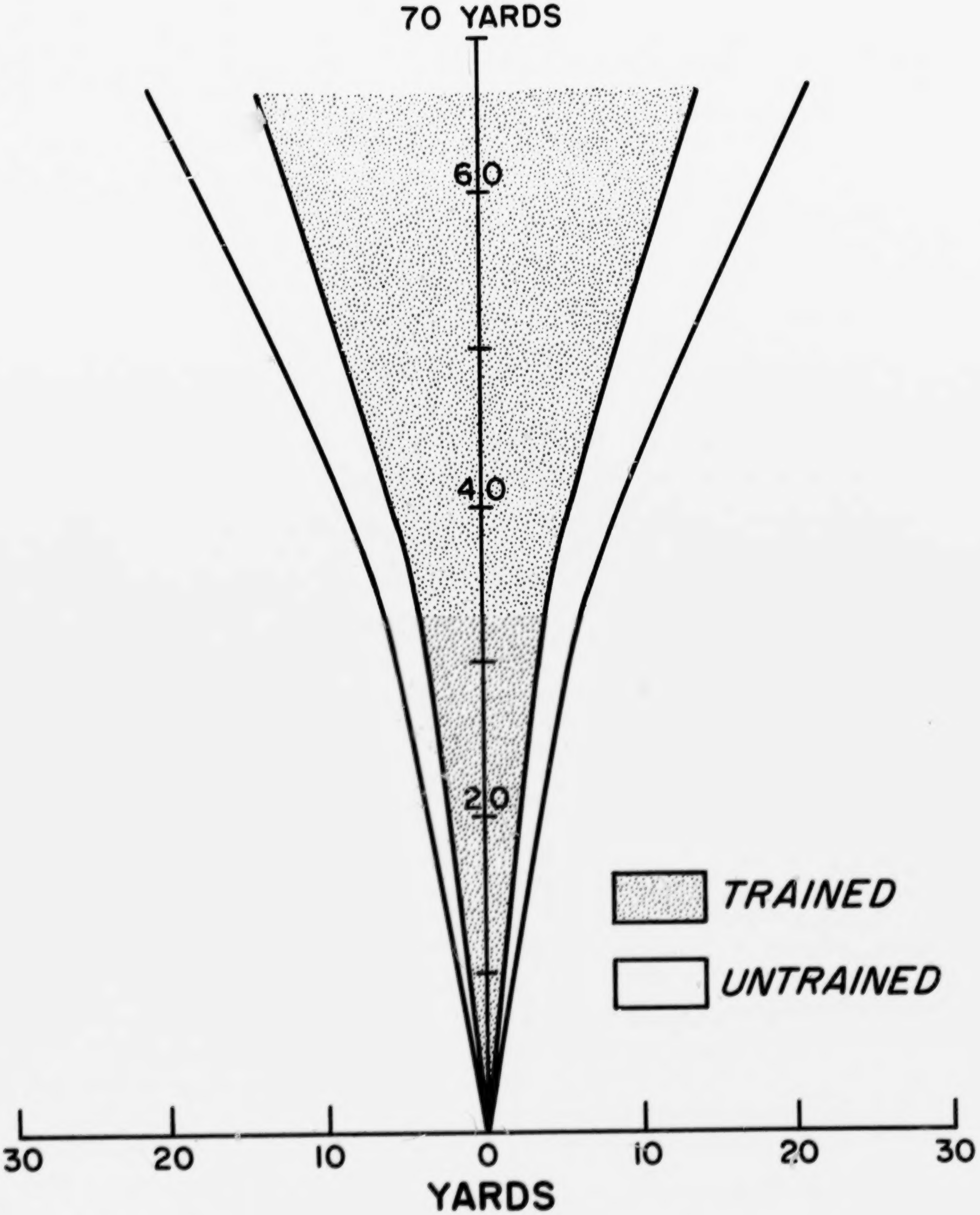
		$\overline{X}$	S^2	N	T-VALUE
100'	Experimental	17.45	193.72	21	
	Control	20.48	168.81	21	.70*
		$\overline{X}$	S^2	N	T-VALUE
200'	Experimental	54.85	810.86	21	
	Control	68.35	740.17	21	1.57*

* not significant at .05

The results of the comparison of the two groups after 'Training' is shown in Table III. These data indicate that the group who received 'brief training'

FIGURE 12.

COMPARISON OF THE MEAN VEER OF "TRAINED" (EXPERIMENTAL) SUBJECTS AND "UNTRAINED" SUBJECTS (CONTROLS): TRIALS FIVE THROUGH EIGHT



tended to veer less than the group who received no training. At 200' on the field, the trained group was significantly more accurate than the nontrained group. Although the experimental subjects were also more accurate at 100' than were the controls, this difference was not significant.[1] Overall the 'trained' individuals seemed to be able to walk a straighter path than did the 'nontrained' individuals. The effect of the 'training' is shown graphically in Figure 12.

Table III

Veering Tendency: Comparison of
Experimental versus Control Groups
After Training (Trials 5-8)

		$\overline{X}$	s^2	N	T-VALUE
100'	Experimental	12.95	71.84	21	
	Control	17.79	196.51	21	1.35
		$\overline{X}$	s^2	N	T-VALUE
200'	Experimental	41.78	1102.17	21	
	Control	62.35	928.76	21	2.09*

T-Value required for significance = 2.02

* significant at .05

Analysis of the effects of brief training on the amount of veer at 60' in the gymnasium revealed no significant differences between 'trained' and untrained' groups. (Table IV).

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[1] Unless otherwise stated, "significant" indicates a .05 level of significance.

Table IV

Veering Tendency: Comparison of
Experimental versus Control Groups:
Gymnasium at 60'

	$\overline{X}$	S^2	N	T-Value
Experimental	8.09	458.42	21	
Control	5.71	853.14	21	1.34

Selected Interrelationships between Veer and Other Measures. Walking Speed. (Average walking speed of the blind subjects was 3.93 feet per second.) Moderate and significant correlations were obtained between walking speed (in feet per second) and the amount of veer at 60' in the gym (-.43) and between walking speed and the amount of veer at 100 on the field (-.60). This indicates, in general, that the faster the individual walked, the straighter was his line of travel. The relationship between walking speed and amount of veer at 200' was low and nonsignificant. (-.29).

Relationships of Gym Veer to Field Veer. A correlation of .78 was obtained when relating the amount of deviation (all subjects) observed at 60' in the gym to the amount of veer observed at 60' on the field. This suggests that a definite relationship exists between veering on the field and veering in the gym. That is, if an individual tends to be accurate in walking a straight line in the gym, he will be equally accurate in his ability to walk a straight line on the field.

Relationship of the Accuracy of Facing Movements to Veer. The correlation between the accuracy of facing movements (a test of directional orientation in which the subject remained relatively fixed) and the veering tendency (a dynamic measure of orientation) was low and nonsignificant. (r= .25) This indicates that there is little relationship between an individual's ability to accurately execute a quarter turn and his ability to walk a straight line on the field.

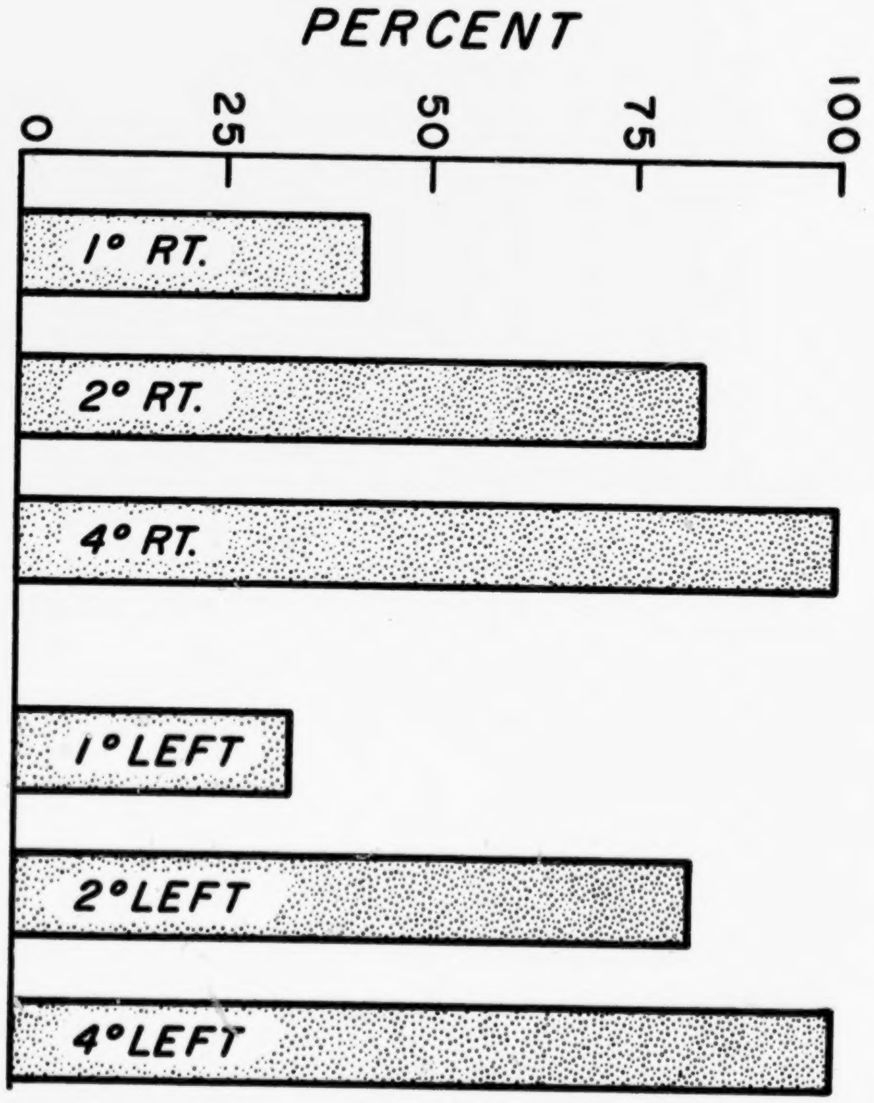
Verbal I. Q. and the Veering Tendency. Correlations were computed (a) to assess the relationship between the effects of brief practice in the veering task (amount of improvement) and the I.Q. of the individual (scores on Verbal W.A.I.S.) and (b) to determine if the amount of veer evidenced on the field (all subjects) was related to I.Q. In both cases low and nonsignificant correlations were obtained: -.33 and -.35 respectively.

Anxiety and Veer. It has sometimes been hypothesized that the anxiety level of the individual may be an important factor affecting the accuracy with which he is able to walk a straight line. A correlation of .10 was obtained between the scores on Taylor's Manifest Anxiety Scale and the scores on the veering task thus indicating little or no relationship between anxiety and the amount of veer the subjects evidenced when attempting to walk a straight line.

In summary, it is apparent that individuals tend to be consistent in their patterns of veer both in the field and in the gymnasium. 91% of the subjects veered consistently in the same direction in the gym while 80.5% veered in the same direction 75% of the time on the field. 54% of the control subjects veered consistently (12 or more trials out of 16) in the same direction in the gymnasium and on the field.

The specific direction in which an individual will veer on one site cannot be predicted from the knowledge of the direction he veers at the other. Brief practice on the part of individuals attempting to walk a straight line on the field affects the accuracy with which they are able to walk this straight path. Briefly trained individuals veer significantly less after walking 200' than do nontrained individuals. Walking speed and veering accuracy are related. That is, the faster an individual walks, the straighter is his line of travel.

Perception of Left-Right Tilt in Pathways Walked. The percentage of subjects reporting sensitivity to 1, 2, and 4 degrees of left and right tilt is shown in Figure 13. 83.7% of the subjects were sensitive to two degrees of right-tilt in the pathways walked while 82.6% of the subjects were sensitive to two degrees of left-tilt in the pathways. There were


PERCENT
0
25
50
75
100
1° RT.
2° RT.
4° RT.
1° LEFT
2° LEFT
4° LEFT

no significant differences in the sensitivity to left and right tilt based on a comparison of these percentages. All subjects were able to detect the presence of 'tilt' when the pathway was tilted 4 degrees.

Overall it appears that the threshold of sensitivity to tilt lies somewhere between 1 and 2 degrees. The apparatus utilized in this study did not permit the collection of data which could thus have more accurately defined this threshold measure.

Facing Movements. The average number of degrees turned on the various turns is presented in Table V. In general, the blind subjects tended to overturn the 90 degree turns by 15 degrees and to underturn the 180 degree turns by 8 degrees. These data closely parallel the data obtained in a pilot study (Chapter II) which involved blindfolded-sighted subjects. Similar to the blindfolded-sighted, the blind also tended to be markedly less accurate on the full or 360 degree turns than on any of the other turns, underturning these turns on the average by 37 degrees. The blind subjects' performances also appeared to be more variable on the full turns (s.d. = 37.4) than on the half (s.d. = 28.7) or quarter turns (s.d. = 26.2).

Table V

Facing Movements:
Average Number of Degrees
Turned on the Various Turns

	90°	180°	360°
All Ss	105°	172°	323°
Right Direction	110°	174°	321°
Left Direction	99°	171°	325°

A two-way analysis of variance was used to determine the influence of Type of Turn and of Individual Subject Differences upon the accuracy of the facing movements. Results of this analysis are shown in Table VI. The main effects of Subjects and of Type of turn were significant. This indicates that both individual differences and type of turn are important factors affecting the accuracy with which facing movements are executed. The presence of the significant interaction between Subjects and Type of Turn further indicates that the resultant behavior observed when a given facing movement is executed depends not only upon the kind of turn to be performed but also upon some unique characteristic of the individual not yet determined.

Table VI
Analysis of Variance Summary:
Facing Movements

Source of Variance	Sum of Squares	d.f.	Mean Square	F-Value	Critical F-Value: .05
Subjects	312809.57	44	7019.31	2.01*	1.67
Turns	36639.06	2	18319.53	5.17**	3.21
Ss x Turns	311803.19	88	3543.22	4.79*	1.67
Repeats (Ss x Turns)	299305.00	405	739.02	------	----
Total	960556.82	539	----	----	----

* Significant at .05
** Significant at .01

Comparisons of the performances of the Experimental (practice) versus the Control (no-practice) groups indicated no significant differences between the two groups in the ability to accurately perform the various facing movements. (Tables VII, VIII, IX)

Table VII
Comparison of Practice-No-Practice
Groups on the Quarter (90°) Turn

Group	$\bar{X}$-Total Error: 4 Trials	S.D.	N	T-Value
Practice	95.09°	79.2	21	T=1.56
No-Practice	60.43°	63.5	21	

t = 2.02, Alpha .05

Table VIII
Comparison of Practice - No-Practice
Groups on the Half (180°) Turn

Group	$\bar{X}$ Total Error: 4 Trials	S.D.	N	T-Value
Practice	88.42°	55.2	21	t=1.69
No-Practice	64.85°	31.9	21	

t = 2.02, Alpha .05

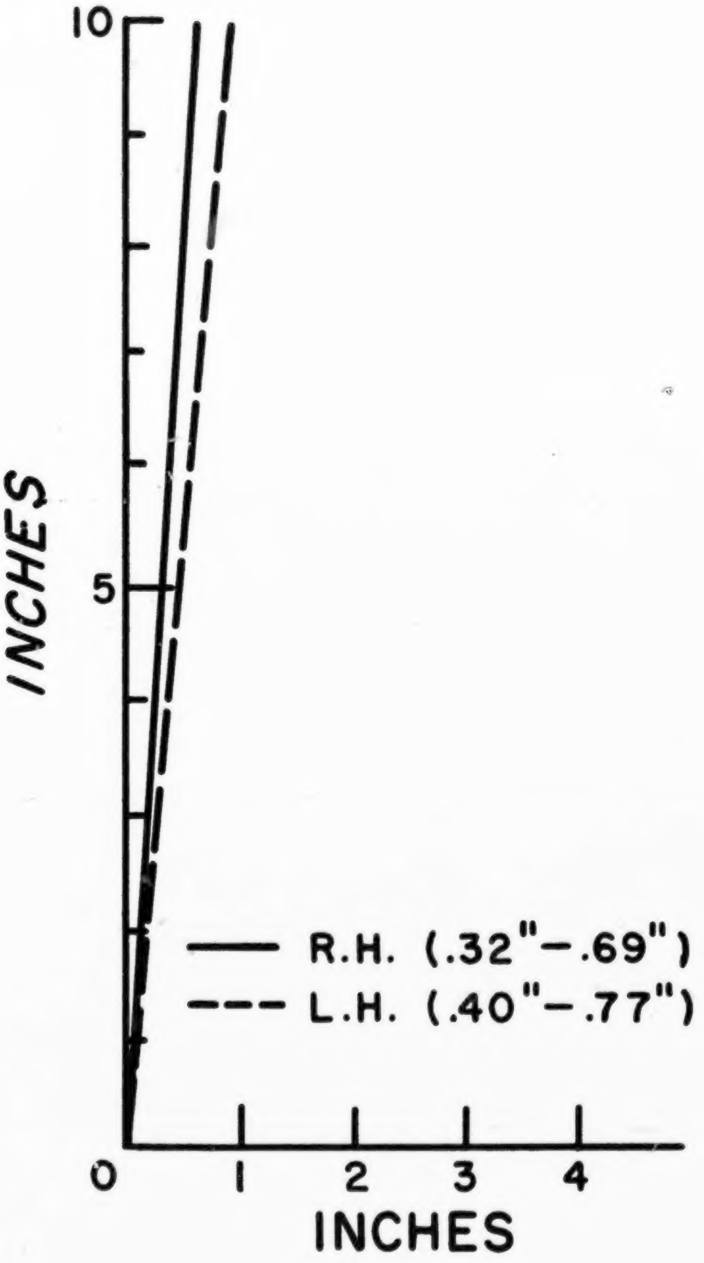
Table IX
Comparison of the Practice - No-Practice
Groups on the Full (360°) Turn

Group	$\bar{X}$ Total Error: 4 Trials	S.D.	N	T-Value
Practice	123.42°	73.2	21	t=.42
No-Practice	113.95°	70.6	21	

t = 2. 02, Alpha .05

Arm Veer. The average arm veer patterns for the right and left hands are shown in Figure 14. In general, the blind subjects tended to veer slightly less when using the right-hand than when using the left. (See Table X) The blind seemed overall to be unable to draw a straight-line directly away from their bodies as accurately as did blindfolded-sighted subjects (Pilot Study, Chapter II). The correlation between the amount of deviation at 5 and 10 inches suggested that the blind subjects were more consistent

FIGURE 14.
MEAN VEER OF THE ARM:
ALL SUBJECTS



in their veering patterns when drawing the line with the right hand (.68) than when drawing it with the left (.47).

Table X

Means and Variances
of Arm-Veer at 5" and 10"

	Right Hand		Left Hand	
	5"	10"	5"	10"
$\bar{X}$	.32"	.69"	.40"	.77"
S^2	.25	1.17	.21	.82

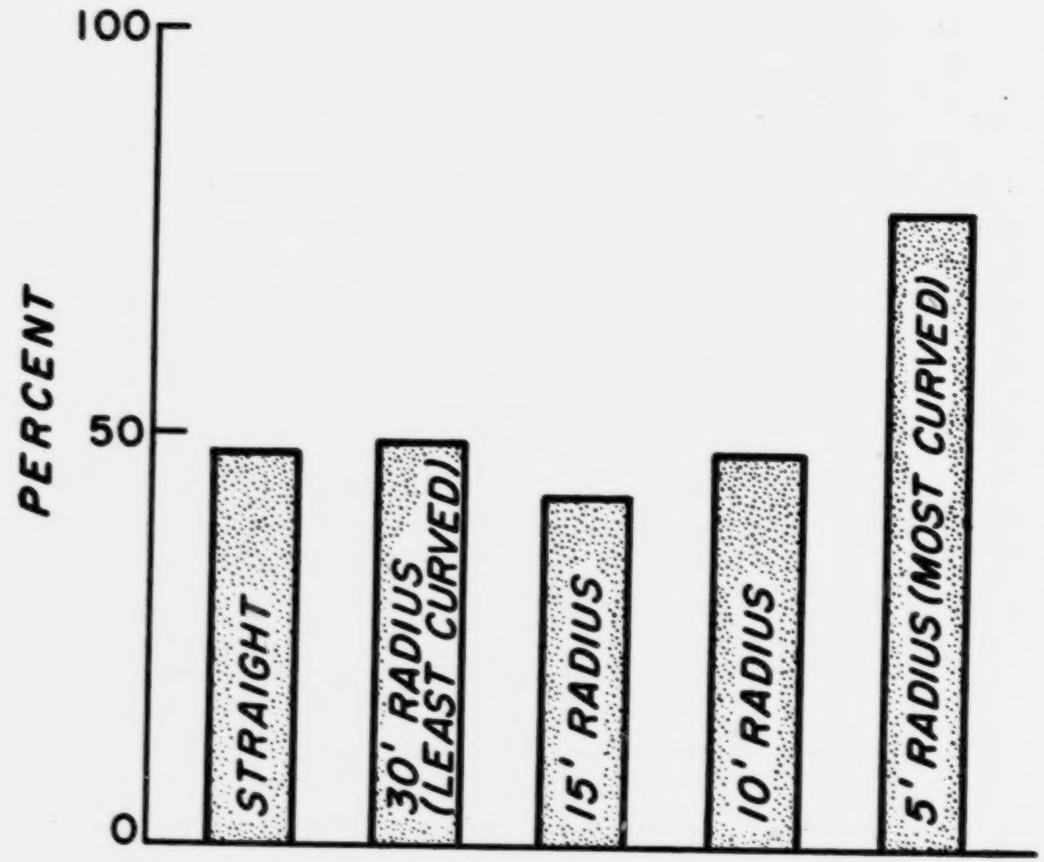
The direction of veer and the hand used to draw the line were not related. (X^2 = 1.00, df = 1). This is in contrast to the performances of the blindfolded-sighted subjects whose direction of veer in the line-drawing task was related to hand used.

Arm Veer versus Veering Tendency-Field. Correlation between the amount of deviation on the table-top line drawing task and the amount of deviation evidenced on the field indicated no significant relationship between the two tasks. (r = .15) A Chi Square Test of Independence was used to assess the relationship between the direction of veer on the table-top and the direction of veer on the field. Results indicated that the probability that the distribution observed was due to chance was .10. The data thus indicates that, in nine cases out of 10, the predominant direction of veer on a table-top line drawing task will be the same as the direction of veer evidenced when attempting to walk a straight line on a field.

Perception of the Curvature of Curbs. As indicated in Figure 15 a threshold to the perception of curvature in curbs was obtained only when the subjects "brailled" a curb with a radius of 5 feet. A 75% response is usually required to establish a threshhold measure in a two-choice discrimination problem as represented by this task (i.e. response requested was either "straight" or "curved"). When the radius of the curb was greater than 5' the accuracy of the subject's responses was no greater than could be expected by chance.

Position Re-location, Field. The mean amount of error (all trials) on the field position re-location task was 10.75'. That is, when subjects were walked on the legs of a right-angle triangle, in both right and left directions, and then asked to return to the original starting point via the hypotenuse of the triangle, they were able only grossly to re-locate their original starting positions on the field, (i.e. they were inaccurate on the average by 10.75'). Slightly greater error was noted on this task after the subjects were walked along the two legs of the triangle to the left (11.35') than when they were walked to the right

FIGURE 15.
PERCENT OF CORRECT RESPONSES TO VARIOUS AMOUNTS
OF CURVATURE IN THE CURBS.



(10.26'). The variability of performances on this task was extremely great as indicated by the s.d. of 33.6' (based on total error for all trials). Subjects tended to be less variable when they were led to the left (s.d. = 15.15) than when they were led to the right (s.d. = 26.23). A comparison of the findings of the present study to those found by Worchel (19) in a similar study indicated that the results of the two were nearly identical. (See Table XI)

Table XI

Worchel vs. Present Study:
Total Return - Left and Right

	Worchel	Cratty and Williams
$\bar{X}$	9.9'	10.75'
SD	6.6	8.40
N	33	42
t	.39	

Position Re-location: Table-top. The mean amount of error (all trials) evidenced on the table-top problem was 1.53" (s.d. = 3.17) The average error observed on those trials in which the subjects initially were moved to their right was 1.52" (s.d. = 1.63);on those in which whey were initially moved to the left, 1.54" (s.d. = 2.01). Similar to the performances on the field re-positioning task, performances on this task tended also to be extremely variable.

Table-Top Position Re-Location versus Field Position Re-Location. Correlation between the mean error on the field and the mean error on the table-top task was .16 indicating that there was no significant relationship between performances on these two tasks. That is, the ability to re-locate a given starting position on the table-top (i.e. using the arms only) was not related to the ability to re-locate a similar starting position on the field (i.e. using the total body).

Comparisons of 'trained' versus 'untrained' groups indicated that there were no significant differences between the two in terms of accuracy of position re-location on the field. (See Table XII). That is, training on the table-top task did not significantly affect the individual's ability to accurately re-locate his position on the field.

Table XII
Comparison of Trained Versus Untrained
Groups on Accuracy of Performance
on the Position Relocation Task

	Left Hypotenuse Return		Right Hypotenuse Return		Total Hypotenuse Return	
	Training	No Training	Training	No Training	Training	No Training
x	9.57'	10.19'	8.90'	7.79'	9.20'	9.54'
SD	5.99	6.03	4.76	5.17	4.70	4.41
N	21	21	21	21	21	21
T	0.33		0.71		0.29	

Relationship to Other Tasks. To determine what other factors might possibly be contributing to the accuracy of the performance of the position re-location task on the field, the following correlations were computed: (a) the mean deviation in the position re-location task and the average error evidenced in the 90 degree facing movement and (b) the mean deviation in the position re-location task and the average veer evidenced at 60' on the field. These correlations were .45 and .41 respectively, indicating that the ability to perform a 90 degree turn and/or to walk a straight line accurately was moderately related to the ability to re-locate a given position on the field.

A multiple correlation between the position re-location task and the other two tasks was =.55, indicating that these latter two tasks (facing movement and veering accuracy) accounted for approximately 30% of the variance of the performances observed in the field position re-location task. This suggests that the ability to walk a straight line as well as the ability to 'turn' the body accurately in space are important factors in spatial re-positioning.

Verbal Portion of the WAIS: The mean I.Q. of the subjects was 115, with a standard deviation of 13.5. Further analyses revealed that, in general, the individuals with higher I.Q.'s tended to be more well adjusted, as scores obtained from Taylor's Test of Anxiety and scores from E. F. I. correlated -.45, and -.33 with scores from the verbal I.Q. measure.

SUMMARY OF FINDINGS

1. The subject population was above average in intelligence (I.Q. = 115), emotionally stable, and relatively free from anxiety. Their average age was 32 years; 45% were blind from birth, the remainder adventiciously blind. The adventiciously blind had become blind at the average age of twenty-five and had on the average, been blind for ten years.

2. Approximately ninety-two percent of the subjects veered in the same direction 75% of the time.

3. The direction the subjects veered on the field was not related to the direction they veered on the level wooden floor; accuracy measures obtained at the two sites were related, however (r = .78).

4. The brief practice designed to aid individual subjects in modifying the veering tendency resulted in significantly greater accuracy after the subjects had walked 200 feet.

5. Walking speed was moderately related to walking accuracy (r = .60), the faster walkers tending to veer less.

6. When asked to execute facing movements, the subjects on the average tended to overturn the 90 degree turns; while underturning 180 degree turns by 8 degrees.

On the 360 degree or full turns the subjects, on the average, underturned by 37 degrees.

7. The threshold to the perception of left and right tilt in pathways walked was slightly under 2°.

8. The threshold to the perception of curvature of curbs was established as subjects "brailled" a "curb" with a radius of 5'. Reports of the subjects pertaining to the curvature of curbs with radii greater than this were no more accurate than those that would be expected by chance.

9. The probability of the association of the direction the subjects veered when attempting to draw a straight line and the direction they veered on the field was .10. In other words, the direction an individual usually veers when attempting to draw a straight line was nine times out of ten, predictive of the direction he habitually veered when attempting to walk a straight line on the field.

10. A multiple correlation between facing-accuracy, veering-accuracy and position re-location on the field was .55. This indicates that performances on the initial two tasks collectively account for about 30% of the accuracy of performances on the latter.

11. Brief training did not significantly affect performance in the facing movements, position re-location on the field, nor in the 'Veering Tendency' during the initial 100 feet of travel.

12. No significant relationships were found between I.Q. and Emotional Stability; I.Q. and trainability in the veering task; Anxiety and the Amount of Veer; Facing Movements and Veering Tendency; Walking speed and Veering Tendency after 200 feet of travel; Amount of veer evidenced on the field; and position re-location on the field versus position re-location on the table-top.

CHAPTER V

DISCUSSION OF THE FINDINGS

The findings summarized on the previous pages relate information which has important practical and theoretical implications. The intent of this chapter is to explore these results, elucidating points which may lead to further productive research and to improved service to the blind.

The Veering Tendency. It is believed that several of the most significant and helpful findings were a result of the exploration of the veering tendency and related tasks. A blind member of the advisory board upon being confronted with the statement that: "The veering tendency is not an important mobility problem!" replied that it was THE main mobility problem of the blind. He further added that if he could walk "straight" he would feel decidedly more capable and confident when traveling the city streets. While the experimenters have no wish to argue this point, it is believed that the findings of this year's investigation have brought to light information which will help to corroborate and/or negate certain assumptions that have been prevalent about the veering tendency in the blind.

The relationship between the direction of veer of the arm and the direction of veer of the total body is perhaps one of the most important findings arising from this investigation. Although the probability of the association of the two behaviors was only .10, it should be extremely helpful to mobility trainers to know that approximately 90% of the time the predominant direction of bodily veer can be determined by simply having the blind client attempt to draw a straight line away from the center of the body. This finding also supports results from the previous investigation in this series which suggested that direction of veer is unrelated to body structure but is due to some assymmetry in the perceptual organization of "straightness." That this "straightness" can be assessed by tasks involving the upper limbs is highly significant. Although further research is, of course, necessary to determine whether table-top training in straight line drawing will significantly alter total body veer, it is clear that this investigation has uncovered a useful diagnostic tool for assessing 'veering' behavior.

It is of further interest to note that the arm-veer evidenced by the sighted in the pilot study seemed to have been more dependent upon some structural quality, for in the majority of cases the arms tended to veer across the body (the right arm to the left and vice-versa) when drawing the "straight" line. On the other hand, the direction of the "straight" lines drawn by the blind did not reveal this 'crossing' phenomena and thus may have been more indicative of some type of general perceptual assymetry.

It has long been hypothesized by the blind that they can walk straighter when they walk at a faster pace. Results of this investigation give support to this hypothesis. The moderate correlation between walking speed and accuracy after walking 100 feet ($r = -.60$) suggests that about 36% of an individual's walking accuracy is dependent upon the speed walked. This finding also fits well into the theoretical framework of the phenomenon of 'blinking' in vigilance tasks (Chapter II). Applied to this particular situation, it is suggested that in order for the blind person to walk in a straight line, he must 'attend' to certain kinesthetic-vestibular cues which help direct the "straightness" of the path he follows. This theory proposes that as the individual continues to walk, it becomes increasingly difficult for him to 'monitor' precisely the kinesthetic-vestibular input associated with the walking movements (i.e. "blinking" occurs), and the individual tends to veer more and more. This. of course, is just what happens as the blind (or blindfolded-sighted) person continues to walk. The additional finding that, after walking 200', the moderate relationship between walking speed and walking accuracy no longer seems to exist, gives further support to this hypothesis.

The similarity in walking accuracy evidenced on the field and that seen on the level wooden surface of the gymnasium suggests that the 'veering' tendency may be more a function of individual differences than of the type of surface walked upon. Schaeffer (16) in his classic study of spiral movement in man arrived at a similar conclusion. However, further research is needed in this area to establish the basis for the relative independence of the direction of veer on the field and the direction of veer on the gymnasium floor. For instance, it is impossible to determine at this point whether the relatively low relationship between the direction of veer evidenced at the two sites was a function of the surface walked or whether it was due to the interpolation of a two-month time lapse between the administration of the two tasks.

The 'tactile brailling' of wires, which provided specific information to the subject about the direction and amount of his veer, had a significant, positive effect upon the "veering" accuracy of the experimental subjects. While differences were seen in mean accuracy at 100 feet, only the differences evidenced at 200 feet of travel were statistically significant. It is important to note that, in most cases, the tactile feedback only delayed the emergence of the natural veer-spiral pattern of the individual. That is, instead of emerging at about 90-110 feet, the 'veering' tendency was delayed until after the individual had walked about 200 feet.

The result of the effect of brief training on the 'veering' tendency clearly points out that the maintenance of accurate mobility is indeed limited when people are dependent solely upon kinesthetic-vestibular cues and/or the 'memory' of a tactile map to which they have been briefly exposed. To be able to walk with extreme accuracy in a direction to which one has been initially oriented seems to require a continuous input from some external stimulus source (sound). Future studies in this series plan to explore the influence of various kinds of sound cues upon accurate mobility.

Facing Movements. In contrast to the dissimilarity between the blind and the blindfolded-sighted performances on the arm-veer task, the data obtained from the assessment of the accuracy of facing movements of the two groups were markedly similar. Both groups tended to overturn 90 degree turns, to underturn a half or 180 degree turn by eight degrees and to markedly underturn the full or 360 degree turn (37 degrees).

The lack of influence of brief practice upon facing movements was not surprising. This practice was engaged in just prior to the performance of the task during the second testing session so that any training effects could easily have been masked by the negative influences.

of attending to this problem for a prolonged period of time. Our findings suggest that such training should be lengthened, should probably be spaced over a period of days, and should be further modified to give the subject a more specific type of feedback about his error in performing the various facing movements. Facing orientation to sound cues as is suggested in the studies by Norton (13), for example, would seem to hold promise.

The lack of a significant relationship between the relatively static measure of directional sense represented by the facing movements task and the dynamic task of directionality represented by the veering task has several implications. It might be suggested that in the 'veering' task, vestibular activity is heightened in an asymmetrical manner as the individual's head moves in a number of planes as he walks, thus circumventing to some degree his accurate sense of direction. When executing facing movements in a relatively motionless standing position no such marked vestibular activity is elicited. Likewise it might be hypothesized that the accurate execution of facing movements depends on some kind of perceptual organization unrelated to kinesthetic cues obtained from the leg-foot movements involved. In contrast, walking a straight line may involve specific processing of kinesthetic input arising from continuous leg movements. In any case, additional studies comparing various measures of static and dynamic spatial orientation should prove valuable.

The Perception of Tilt in Pathways Walked. A survey of the findings of both investigations suggests that the blind are most sensitive to decline (threshold = 1°) and least sensitive to incline and left-right tilt (threshold about 2°). These findings together with other findings pertaining to the perception of curvature in pathways and the veering tendency of the blind suggest that the mobility trainer, when attempting to teach a blind client a new environment (i.e. a college campus),should first draw a map of the area outlining in some detail the gradients of the area, the relatively consistent noise characteristics of the environment, and the horizontal curvature of pathways which his client can be expected to perceive. With such a map the trainer is making effective use of all of the sources of input available to the client.(i.e. sound as well as kinesthetic-vestibular information). Most important of all such a training device can now be based upon a reference system established by scientific assessment of the perceptual capacities of the blind and not upon a reference system dependent upon the visual judgments of the trainer.

Perception of the Curvature of Curbs. In the absence of any written material relative to techniques used to determine the curvature of curbs, each subject was permitted to employ his own method to establish the presence or absence of curvature in the curbs. Most subjects, stood facing the curb, approximately one foot away from its edge and moved the cane, using one hand, several times along its edge prior to making any judgments. It was apparent in pilot studies that blindfolded-sighted individuals, when presented with this kind of task, could discriminate curvature only within very broad limits. The curb which the blind could accurately judge as being curved was one having a radius of 5 feet. Information from the Building Department of the local municipal government indicated that the radii of curbs in Los Angeles varies from 15 to 25 feet depending upon the width of the street. Thus in Los Angeles, using the techniques the blind themselves selected for this task, the probability that a blind person can accurately determine whether he is proceeding from a straight or curved curb is no better than chance.

Most of the cane techniques described verbally to the investigators by the mobility trainers were based primarily upon arm movements. One technique was described in which individuals were told to face the curb, and pass the cane vertically across the body from hand to hand. Care was taken to instruct the subject to refrain from any bodily movement at all. Basic research in a number of areas suggests that the present methods used to assess the configurations of curbs are faulty. Most of these techniques require that a judgment be made solely on the basis of arm movements; while research indicates that when more of the body is involved in an action, more accurate judgments can be made. One technique, which was found to be least accurate of all, requires that the judgment of the curvature be based primarily upon position differences of the arm as it is moved, shoulder height and parallel to the ground, to the sides of the body. (Subject faces curb). A considerable amount of research in the human factors area (10) supports the notion that the most accurate judgments of this type are made in front of the body and not to the side.

Inspection of the previous year's findings concerning the perception of curvature in pathways walked suggests that perhaps the most effective way of determining whether a curb is curved or not may be to hold the cane immobile along the side of one leg with the tip of the cane extending over the side of the curb. Using this method the individual should then attempt to walk parallel to the curb, and if he perceives himself to be walking in an arc (and our previous research suggests that he is able to do this if the arc walked is on a circle with a radius of 60 feet or less), then the curb is indeed curved. If, on the other hand, when holding the cane in this manner, he perceives himself to be walking a straight pathway, he most likely is adjacent to a straight curbing from which it would be safe to cross the street.

Position Re-Location. Unlike the positive relationship found between the direction of table-top veer and field veer, no significant positive relationships were found between position relocation on the field and on the table-top. The brief table-top training engaged in did not significantly improve the ability of the experimental subjects to accurately re-locate a given 'starting' position when they returned to the field. Other relationships were obtained, however, which hold significance for the primary focus of these investigationsas well as for the specific information they contain.

A multiple correlation between veering accuracy on the field, facing movement accuracy (90° turns), and the ability to re-locate one's original 'starting' position on the field was positive and moderately high ($r = .55$). This in addition to cognitive influences involved in the ability to re-locate a given position without vision, the basic abilities to walk a straight line and to turn the body accurately in space also account for a substantial percentage of the variance involved in the performance of this kind of discrimination task. It is believed that such a finding gives additional support to the importance of analyzing the parts of a task before proceeding to the complex whole. Several investigators have constructed complex obstacle courses or have contrived courses in communities by which to assess the perceptual-motor capacities of the blind (12) (14). While valuable information may be obtained in this way, it is believed that other studies should be planned to assess (a) what parts contribute to whole and (b) in what ways they contribute. Only through careful analysis of the components of mobility tasks can one really be certain about the relative contribution of various factors to the complex problem of the mobility of the blind on the city streets.

In addition, it was found that the brief training in position re-location had a definite positive effect upon the performance of two girls whose I.Q.'s indicated moderate retardation (I.Q.'s = 88 and 74). In one case, for example, the subject deviated in her attempt to re-locate her position on the field by 132 feet. After training her deviation was only 12 feet. Such data indicate that two individuals who had mild perceptual handicaps were aided by the type of training engaged in.

Intelligence, Anxiety, Emotional Stability. Similar to Schilling's study (14), a moderate correlation was found between emotional stability and I.Q. It is difficult to determine, however, whether or not the brighter subjects might also have been more sensitive to the type of answer a "well-adjusted" person would be expected to make on the E.F.I. or whether some slight relationship does, in fact, exist between the two variables.

The data obtained from the WAIS, E.F.I. AND Taylor's Scale were skewed in a positive direction. That is, the subjects were emotionally well-adjusted, relatively free from anxiety and above average in intelligence. (Two had I.Q.'s of 134 and 139). Thus the findings from this investigation are perhaps pertinent only to a similar population of blind subjects. At the same time it is to be expected that just this type of individual would volunteer to participate in research projects and to come to the University to be tested. Welford and others (18) have also mentioned this kind of sampling problem when administering performance tests to older factory workers in England.

The population studied in this investigation was also far younger than the general blind population of the United States. The average age of this subject population was 32 years; that of the general blind population is considerably older (65 years). The reader should be sensitive to the limitations which these differences in ages may have in the application of these findings to the blind population as a whole.

Relationships involving I.Q., 'anxiety,' and E.F.I. performances also require careful interpretation in the light of the fact that these distributions were all limited in range of scores and were positively skewed. Thus, although it was anticipated that a relationship might exist between 'anxiety' and walking speed, it was for the reason stated above that this and other similar correlations were omitted.

SUMMARY

In general, conclusions arrived at following the first year of study were confirmed. The investigators were reinforced in the feeling that perceptual-motor discriminations made without vision are different from those possible within a visual reference system. At times non-visual judgments are more precise than visual ones; at other times, they are less so. For example, the sighted can see curvature in a pathway walked or in 'curbs' when the blind are unable to detect this same amount of curvature via tactile-kinesthetic sources of information. At the same time, the blind are more sensitive to gradient and tilt in pathways walked than are sighted individuals who visually inspect these same surfaces.

It is with conviction that the investigators have arrived at the general conslusion that to effectively train the blind, a trainer must understand the' reference system of the sightless and attempt to understand the perceptual motor limitations of his clients.

He should never presuppose that certain discriminations are possible because he, the sighted, can make them. Furthermore, the investigators are convinced that to understand the perceptual-motor capacities possible within a non-visual reference system, one must not depend solely upon distortable personal experience, but must also adhere to and put faith in the scientific method of problem solving. The present investigators have the greatest respect for the diligent and hard working mobility trainer (or peripatologist) for the number of variables with which he must deal hourly, when working with his blind clients, are numerous. It is hoped that these studies have helped to clarify the nature of some of the variables with whidh the mobility trainer must daily contend.

The writers have similarly gained a great respect for the insight and judgment of the blind. The suggestions received from many of them are reflected in the investigations described on these pages. It is hoped that both the blind and their helpers will, in the future, aid us by extending suggestions and comments which might enhance the interpretation and use of these findings and in designing other studies which will further elucidate the nature of the judgments possible within a non-visual reference system.

CHAPTER VI

SUMMARY OF THE INVESTIGATION

Forty-three blind subjects ranging in age from 17 to 45 were brought to the University Campus for two separate days of testing, separated by a two month interval. The attributes assessed were: the 'veering' tendency, in a gymnasium and on a field; the ability to discriminate left and right tilt in pathways walked, the perception of the curvature of curbs; the ability to perform facing movements accurately; the ability to re-locate a position on a field and on a table-top graph; and the ability to draw a straight line directly away from the center of the body. In addition, data describing the subjects' verbal I.Q., emotional stability, and level of anxiety were obtained. The effects of brief training on the veering tendency, the ability to make accurate facing movements, and the ability to re-locate a position on a field were also studied.

Analyses of the data revealed the following:

1. The subject population was above average in intelligence (mean I.Q. = 115), emotionally stable, and relatively free from anxiety.

2. Approximately 91% of the subjects veered consistently (75% of the time) in the same direction when

asked to walk a straight line. The direction a subject consistently veered on the field, however, was independent of the direction he habitually veered in the gymnasium.

3. The subjects who walked faster tended to veer less. (r = -.60). Subjects who were more accurate in walking a straight line and who performed 90° facing movements more precisely tended to be better able to accurately re-locate their position on a field after being walked away from it.

4. The threshold to the perception of left-right tilt in pathways walked was slightly under 2°. Overall the blind seemed more sensitive to walking a downhill-gradient (threshold = 1°) than to walking either an uphill gradient (threshold = 2°) or a surface slanted to the right or left (threshold under 2°).

5. When asked to execute facing movements, the blind and the blind-folded-sighted tended to overturn 90° turns (average error = 10 - 15), to underturn 180° turns by approximately 8°, and to markedly underturn 360° turns (mean error = 37°). The ability to execute accurate facing movements was unrelated to the veering tendency.

6. Brief practice modified the veering tendency slightly (not statistically significant) at 100 feet of travel and resulted in a significantly straighter path walked after the individual had traveled 200 feet.

7. The direction a subject habitually veered when attempting to draw a straight line was (p = .10) related to the direction they habitually veered when attempting to walk a straight line on an athletic field.

8. Brief training did not significantly affect accuracy in facing movements nor in position re-location on the field.

9. No significant relationships were found to exist between I.Q. and trainability in the 'veering' task; anxiety and amount of veer; or between position re-location on a table-top and position re-location on the field.

The suggestion was proposed by the investigators that mobility trainers might 'map-out' areas to be learned by a blind client including gradients, curvature of pathways present in the area, consistent auditory cues and the like, prior to beginning the process of learning this new environment. Reference to the kind of data presented here, combined with the mobility trainer's personal experience and insights, should prove helpful when attempting to understand the reference system within which the blind formulate judgments about their environment.

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